THE NEWTONIAN SYSTEM OF PHILOSOPHY

Adapted to the Capacities of young
Gentlemen and Ladies, and familiarized and made entertaining by Objects with which they are intimately
acquainted:

BEING

The Subſtance of Six Lectures read to the
Lilliputian Society,

By TOM TELESCOPE, A.M.

And collected and methodized for the Benefit
of the Youth of theſe Kingdoms,

By their old Friend Mr. Newbery, in *St. Paul's Church Yard*;

Who has alſo added Variety of Copper-Plate Cuts, to
illuſtrate and confirm the Doctrines advanced.

O Lord, how manifold are thy Works! In Wiſdom haſt thou made them all, the Earth is full of thy Riches.

Young Men and Maidens, Old Men and Children, praiſe the Lord. Psalms.

LONDON,
Printed for J. Newbery, at the Bible and Sun,
in *St. Paul's Church Yard.* 1761.

TO THE
Young GENTLEMEN and LADIES
OF
Great Britain and *Ireland*,
This Philoſophy of *Tops* and *Balls*
Is humbly inſcribed,
By their moſt obedient Servant,
J. NEWBERY.

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INTRODUCTION,

Being the Subſtance of

A LETTER to the Hon. ****

Dear Sir,

I Am deſired by the Marchioneſs of *Setſtar* to give you ſome account of thoſe young Gentlemen and Ladies whom you ſaw enter the ſaloon the morning you left us, and who came to his Lordſhip's ſeat on an adventure the moſt extraordinary and the moſt to be admired of any I ever knew. You may remember it was holiday time, and theſe little gentry being come from ſchool met firſt at the Counteſs of *Twilight*'s to divert themſelves; where they were ſo divided in their taſte for amuſements, that warm debates enſued. One propoſed *Threading the*

Needle, another *Hot-cockles*, a third *Shuttle-cock*, a fourth *Blind-Man's-Buff*; and at laſt *Cards* were mentioned. Maſter *Teleſcope*, a young Gentleman of diſtinguiſhed abilities, ſat ſilent, and heard all with complacency and temper till this diverſion was propoſed; but then he ſtarted from his ſeat, and begged they would think of ſome more innocent amuſement. Playing at cards for money, ſays he, is ſo nearly allied to covetouſneſs and cheating, that I abhor it; and have often wondered, when I was at *Bath* with my papa, how people, ſeemingly of years of diſcretion, could ſo far miſtake themſelves, and abandon common ſenſe, as to lead a young *urchin* juſt breeched, or a little *doddle-my-lady* in hanging ſleeves, up to a gaming-table, to play and bet for ſhillings, crowns, and perhaps guineas, among a circle of ſharpers. Parents, continued he, might almoſt as well teach their children to thieve as to game; for they are kindred employments, and generally terminate in the ruin of both fortune and character. Lady *Twilight*, who is no friend to the modern modes of education, ſmiled at this young gentleman's remark, and deſired him to point out ſome diverſion himſelf. 'Tis impoſſible for me, Madam, ſays he, to find out an amuſement ſuitable to the taſte of the company, unleſs I was perfectly acquainted with their diſpoſitions; but were I to chuſe, I ſhould prefer thoſe which not only divert the mind, but improve the underſtanding: and ſuch are many of the diverſions at the ſchool where I am placed. We often play at *ſham Orations, comical Diſputes, meaſuring of Land and Houſes, taking the Heights and Diſtances of Mountains and Steeples, ſolving Problems and Paradoxes on Globes and Maps*, and ſometimes at *Natural Philoſophy*, which I think is very entertaining, and at the ſame time extremely uſeful; for whether our knowledge is acquired by theſe amuſements, and reading little books, or by ſerious and elaborate ſtudy, what is obtained will be equally ſerviceable: nay, perhaps that which is acquired in the entertaining manner may have the advantage; for, as it is conveyed to the mind with a train of pleaſing ideas, it will be the more permanent and laſting, and the eaſier called up by the memory to our aſſiſtance.

The Counteſs was very deſirous of knowing what ſort of diverſion could be made of Natural Philoſophy; and finding her young viſitors in the ſame diſpoſition, ſhe conducted them to the Marquiſs of *Setſtar*'s, that they might have the uſe of proper inſtruments. As my Lord Marquiſs was engaged in company, Lady *Twilight*, though nearly related to his Lordſhip, would not diſturb him, but led them through the ſaloon into a private parlour, where our little Philoſopher, at the requeſt of her Ladyſhip, immediately opened the Lecture, without making idle excuſes, or waiting for farther ſolicitations, which he knew would be ill manners.

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LECTURE I.

Of MATTER *and* MOTION.

BY *Matter*, my dear friends, *we mean the ſubſtance of all things*, or *that* of which all bodies are compoſed, in whatever form or manner they may preſent themſelves to our ſenſes: for this top, *Tom Wilſon*'s ivory ball, the hill before us, that orange on the table, and all things you ſee, are made of matter differently formed.

As to *Motion*, I may ſave myſelf and you the trouble of explaining that; for every boy who can whip his top knows what motion is as well as his maſter.

Matter, or *Body*, *is indifferent to motion or reſt*. As for example, now I whip my top, and it runs round, or is in motion; but when I no longer whip it, the top falls down, as you ſee, and is at reſt.

When a body is in motion, as much force is required to make it reſt, as was *required, while it was at reſt, to put it in motion.* Thus, ſuppoſe a boy ſtrikes a trap-ball with one hand, and another ſtands cloſe by to catch it with one of his hands, it will require as much ſtrength or force to ſtop that ball, or put it in a ſtate of reſt, as the other gave to put it in motion; allowing for the diſtance the two boys ſtand apart.

No body or part of matter can give itſelf either motion or reſt: and therefore a body at reſt will remain ſo for ever, unleſs it be put in motion by ſome external cauſe; and a body in motion will move for ever, unleſs ſome external cauſe ſtops it.

This ſeemed ſo abſurd to Maſter *Wilſon*, that he burſt into a loud laugh. What, ſays he, ſhall any body tell me that my hoop or my top will run for ever, when I know by daily experience that they drop of themſelves, without being touched by any body? At which our little Philoſopher was angry, and having commanded ſilence, Don't expoſe your ignorance, *Tom Wilſon*, for the ſake of a laugh, ſays he: if you intend to go through my Courſe of Philoſophy, and to make yourſelf acquainted with the nature of things, you muſt prepare to hear what is more extraordinary than this. When you ſay that nothing touched the top or the hoop, you forget their friction or rubbing againſt the ground they run upon, and the reſiſtance they meet with from the air in their courſe, which is very conſiderable though it has eſcaped your notice. Somewhat too might be ſaid on the gravity and attraction between the top or the hoop, and the earth; but *that* you are not yet able to comprehend, and therefore we ſhall proceed in our Lecture.

A body in motion will always move on in a ſtrait line, unleſs it be turned out of it by ſome external cauſe. Thus we ſee that a marble ſhot upon the ice, if the ſurface be very ſmooth, will continue its motion in a ſtrait line, till it is put to reſt by the friction of the ice and air, and the force of attraction and gravitation.

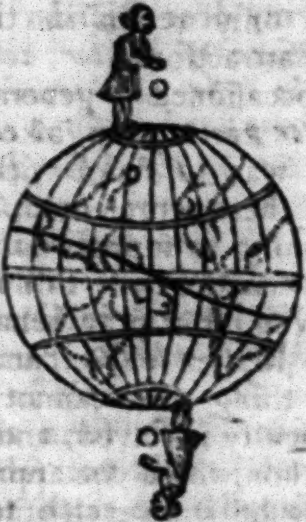
The ſwiftneſs of motion is meaſured by diſtance of place, and the length of time in which it is performed. Thus if a cricket-ball and a fives-ball move each of them twenty yards in the ſame time, their motions are equally ſwift; but if the fives-ball moves two yards while the cricket-ball is moving one, then is the motion of the fives-ball twice as ſwift as the other.

But the quantity of motion is meaſured by the ſwiftneſs of motion, as above deſcribed, and the quantity of matter moved conſidered together. For inſtance, if the cricket-ball be equal in bulk and weight to the fives-ball, and move as ſwift, then it hath an equal quantity of motion. But if the cricket ball be twice as big and as heavy as the fives-ball, and yet moves equally ſwift, it hath double the quantity of motion; and ſo in proportion.

All bodies have a natural tendency, attraction, or gravitation towards each other. Here *Tom Wilſon*, again laughing, told the company that Philoſophy was made up of nothing but hard words. That is becauſe you have not ſenſe enough to enquire into, and retain the ſignification of words, ſays our Philoſopher. All words, continued he, are difficult till they are explained; and when that is done, we ſhall find that gravity or gravitation will be as eaſily underſtood as praiſe or commendation, and attraction as eaſily as correction; which you deſerve, *Tom Wilſon*, for your impertinence.

Gravity, my dear friends, *is that univerſal diſpoſition of matter which inclines or carries the leſſer part towards the centre of the greater part; which is called* weight *or gravitation in the leſſer body, but* attraction *in the greater, becauſe it draws, as it were, the leſſer body to it.* Thus all bodies on or near the earth's ſurface have a tendency, or ſeeming inclination, to deſcend towards its middle part or centre; and but for this principle in nature, the earth (conſidering its form and ſituation in the univerſe) could not ſubſiſt as it is: for we all ſuppoſe the earth to be nearly round, (nay, we are ſure it is ſo, for my Lord *Anſon* and many other gentlemen, you know, have ſailed round it) and as it is ſuſpended in ſuch a mighty void or ſpace and always in motion, what ſhould hinder the ſtones, water, and other parts of matter falling from the ſurface, but the almighty arm of God, or this principle or univerſal law in nature, of attraction and gravitation, which he has eſtabliſhed to keep the univerſe in order. To illuſtrate and explain what I have ſaid, let us ſuppoſe the following figure to be the earth and ſeas. Let *Tom Wilſon* ſtand at this point of the globe or earth where we are,

and



and *Hal Thompſon* at the oppoſite part of the earth, with his feet (as they muſt be) towards us: if *Tom* drop an orange out of his hand, it will fall down towards *Hal*; and if *Hal* drop an orange, it will fall ſeemingly upwards (if I may ſo expreſs myſelf) towards *Tom:* and if theſe oranges had weight and power ſufficient to diſplace the other particles of matter of which the earth is compoſed, ſo as to make way to the centre, they would there unite together and remain fixed; and they would then loſe their power of gravitation, as being at the center of gravity and unable to fall, and only retain in themſelves the power of attraction.

This occaſioned a general laugh; and *Tom Wilſon* ſtarting up, aſked how Maſter *Thompſon* was to ſtand with his feet upwards, as here repreſented, without having any thing to ſupport his head? Have patience, ſays the little Philoſopher, and I will tell you; but pray behave with good manners, Maſter *Wilſon*, and don't laugh at every thing you cannot comprehend. This difficulty is ſolved, and all the ſeeming confuſion which you apprehend of bodies flying off from each other is removed, by means of this attraction and gravitation. Aſk any of the ſailors who have been round the world, and they will tell you that the people on the part of the globe over-againſt us do not walk upon their heads, though the earth is round; and though their heels are oppoſite ours, they are in no more danger of falling into the mighty ſpace beneath them, than we are of falling (or rather riſing I muſt call it here) up to the moon or the ſtars.

But beſides this general law of attraction and gravitation, which affects all bodies equally and univerſally, there are particular bodies that attract and repel each other, as may be ſeen by the *Magnet* or *Loadſtone*, which has not only the property of directing the needle of the mariner's compaſs when touched with it to the north, but alſo of attracting or bringing iron to it with one end, and repelling or forcing it away with the other end: and *Sam Jones's* knife, which was whet on a Loadſtone ſome years ago, ſtill retains the power you ſee of picking up needles and ſmall pieces of iron.

Glaſs, *Sealing-Wax*, *Amber*, and *Precious Stones*, when chaſed or rubbed till they are warm, will likewiſe both attract and repel feathers, hairs, ſtraw, &c. which is ſufficient to prove that each of theſe bodies has a ſphere of attraction aſſigned it, beyond which it will repel the ſame body it would otherwiſe attract.

When bodies are ſo attracted by each other as to be united or brought into cloſe contact, they then adhere or cohere together ſo as not to be eaſily ſeparated, and this is called in Philoſophy the *Power of Cohesion*, and is undoubtedly that principle which binds large bodies together; for all large bodies are made up of atoms or particles inconceiveably ſmall. And this cohesion will be always proportioned to the number of particles or quantity of the ſurface of bodies that come into contact or touch each other; for thoſe bodies that are of a ſpherical form will not adhere ſo ſtrongly as thoſe that are flat or ſquare; becauſe they can only touch each other at a certain point; and this is the reaſon why the particles of water and quickſilver, which are globular or round, are ſo eaſily ſeparated with a touch, while thoſe of metals and ſome other bodies are not to be parted but with great force. To give us a familiar inſtance of this coheſion of matter, our Philoſopher took two leaden balls, and filing a part off each ſo that the two flat parts might come into cloſe contact, he gently preſſed them together and they united ſo firmly that it required conſiderable force to get them aſunder.

One thing I muſt tell you of magnetiſm, which ſeems pretty extraordinary. Maſter *Brown* took his uncle's ſword, and ſupported it with the point downwards, by reſting the ſhell of the hilt on the top of his two forefingers; and Maſter *Smith* was placed with his father's amber-headed cane at about three or four feet diſtance, where he kept rubbing the amber head round on his waiſtcoat. After ſome little

time

time the ſword began to move, tho' at that diſtance; and ſome time after that it turned quite round; but was ſoon turned back again by maſter *Smith*'s rubbing the amber head backwards, or in a contrary direction.

But what ſeems moſt worthy of our admiration is the Electrical Fire, which ſo plentifully abounds in the univerſe, and which is excited, or made viſible, by the friction or rubbing of a glaſs globe. This fire, by a very ſimple machine, may be conveyed into the human body, every part of which it pervades in an inſtant, and is ſaid to have been very ſerviceable in the cure of ſome diſorders. It may be drawn from the ladies eyes, yet leaves them no leſs brilliant than they were before. It may be drawn from thunder-clouds, and is probably the ſame ſpecies of fire with the lightning; for Profeſſor *Richmann* of *Hamburgh*, who fixed a machine to bring it down from the clouds in large quantities, was killed by the ſtroke it gave him.

The ſame force applied to two different bodies will always produce the ſame quantity of motion in each of them. To prove this, we put Maſter *Jones* into a boat, which (including his own weight) weighed ten hundred, on the *Thames* by the *Mill-bank*; and on the *Lambeth* ſide, juſt oppoſite, we placed another boat (of one hundred weight) with a ſtring tied to it. This ſtring Maſter *Jones* pulled in the other boat; and we obſerved that as the boats approached each other, the ſmall boat moved ten feet for every foot the other moved; which proves what we have before obſerved as to the quantity of motion.

Attraction is the ſtronger, the nearer the attracting bodies are to each other; and in different diſtances of the ſame bodies it decreaſes as the ſquares of the diſtances between the centres of thoſe bodies increaſe. For if two bodies at a given diſtance attract each other with a certain force, at half the diſtance they will attract each other with four times that force. But this I ſhall farther explain in my next courſe of Lectures.

Two bodies at a diſtance will put each other into motion by the force of Attraction or Gravitation. This we know to be true by experience, though we cannot account for it; and therefore it is to be received as a principle in Natural Philoſophy.

Here Maſter *Wilſon*, again interrupting him, ſaid that could not be true; for if two bodies at any diſtance could put one another in motion by their power of attraction, the earth and the moon would move towards each other in a ſtrait line, and unite; and then, ſays he, laughing, all Dr. *Wilkins*'s machines for flying thither would be uſeleſs.

But you ſhould conſider, ſays the Philoſopher, if a body, that by the attraction of another would move in a ſtrait line towards it, receives a new-motion any ways oblique to the firſt, it will no longer move in a ſtraight line, according to either of theſe directions, but in a curve that will partake of both. And this curve will differ according to the nature and quantity of the forces that concurred to produce it: as for inſtance, in many caſes it will be ſuch a curve as ends where it begun, or recurs into itſelf; that is, makes up a circle, like this ball; or an ellipſis or oval, like this egg, which ſhall be farther explained in our next courſe of Lectures.

Here Master *Wiggs*, again interrupted him, and that could not be true; for if two bodies at any distance could put one another in motion by their powers of attraction, the earth and the moon would move towards each other in a strait line, and unite; and then, said he, farewel all Dr. *[illegible]*'s machines for [illegible] together would be useless.

But you should consider, says the Philosopher, if a body [illegible] by the attraction of another would move in a strait line toward it, it receives a power [illegible] ways oblique to the [illegible] in a straight [illegible] these directions [illegible] particles of [illegible] tity of the force [illegible] will be [illegible] [illegible] this [illegible] shall be further [illegible] in our [illegible]

BRITISH 15 DE 93 MUSEUM

The Marquiſs of Selistan's Observatory

LECTURE II.

Of the UNIVERSE, *and particularly of the* SOLAR SYSTEM.

THE laſt Lecture was read at the Marquiſs of *Setſtar*'s, who was ſo well pleaſed at theſe young gentlemen's meeting thus to improve themſelves, that he ordered them to be elegantly treated with tarts, ſweatmeats, ſyllabubs, and ſuch other dainties as his Lordſhip thought were moſt proper for youth: and I muſt obſerve, that the Marchioneſs did them the honour of her company, and was particularly pleaſed with the converſation of Maſter *Teleſcope*. As it was a moonlight night, her Ladyſhip, after ſupper, led them to the top of a tower, where his Lordſhip has an obſervatory furniſhed with all the inſtruments neceſſary for aſtronomical and philoſophical obſervations; and the place itſelf is the beſt that can be conceived for enquiries of this kind, and for meditation. To ſee an extenſive horizon thus ſhaded by the brow of night, and at intervals brightened up by the borrowed light of the moon dancing among the clouds, was to me inexpreſſibly pleaſing. Nothing was heard but a gentle breeze whiſpering the top of the battlements; the dying murmurs of a diſtant caſcade; the melancholy hootings of the bird of night, who kept watch in an ivy tower near us; the manſion clock, that recorded the time; and old Echo, who repeated the hours from the ſide of a rock, where ſhe has ſecluded herſelf ever ſince the deluge. Night, the nurſe of Nature, had huſhed all things elſe to ſilence.---But ſilence was ſoon broke by our Philoſopher, who thus began his Lecture.

Look round, my dear friends, ſays he, you ſee the earth ſeems to be bounded at an equal diſtance from us every way, where it appears to meet the ſky, that forms this beautiful arch or concave over our heads. Now that diſtance round, where we loſe ſight of the earth, is called the horizon; and when the ſun, moon, and ſtars emerge from beneath and come into our ſight, we ſay they are riſen, or got above the horizon. For all this glorious canopy beſpangled with lights, that bedeck the ſky and illuminate the earth, as the *Sun*, the *Fixed Stars*, the *Comets* and *Planets*, (to which laſt our *Earth* and the *Moon* belong) have all apparent motions, as may be perceived by the naked eye; tho' in fact none move but the planets and comets, as will be proved hereafter.

But beſides the ſtars which we ſee, there are others not diſcernible by the naked eye, ſome of which are fixed ſtars, and ſome are bodies moving about the moſt diſtant planets, which were inviſible and unknown to us before the diſcovery of proſpective glaſſes.---Pray hand me the reflecting teleſcope---Here it is.

And the refracting teleſcope, if you pleaſe. ---Oh, here it is alſo.

If you uſe the reflecting teleſcope, you muſt turn this ſcrew on the ſide of it till you can ſee the object you want to examine in the moſt perfect manner: and if you uſe the refracting teleſcope, you muſt move backwards or forwards this ſmall part, till you have adjuſted it to your ſight. Then look at that part of the heavens where I have pointed them, or indeed any other part, and you will perceive more ſtars than you ſaw before with your eye alone. Theſe are fixed ſtars, and are called fixed becauſe they always keep the ſame diſtance one from another, and the ſame diſtance from the ſun, which is ſuppoſed to be alſo fixed; and was he placed at the immenſe diſtance they are at, would propably appear no bigger than one of them. Hence ſome Philoſophers have concluded, and I think not without reaſon, that every fixed ſtar is a ſun, that has a ſyſtem of planets revolving round it, like our ſolar ſyſtem. And if ſo, how immenſely great, how wonderfully glorious, is the ſtructure of this univerſe, which contains many thouſand worlds, large as ours, ſuſpended in æther, rolling like the earth round their ſeveral ſuns, and filled with animals, plants, and minerals, all perhaps different from ours, but all intended to magnify the Almighty Architect; *who weighed the mountains in his golden ſcales, who meaſured the ocean in the hollow of his hand, who drew out the heavens as a curtain, who maketh the clouds his chariot, and walketh upon the wings of the wind.*

The fervour and air of piety with which he delivered this, ſilenced all his companions, and gave infinite ſatisfaction to the Marchioneſs. Maſter *Wilſon*, who had before been very impertinent, began now to conſider himſelf as a fool in compariſon of our Philoſopher; and as Maſter *Teleſcope* had mentioned the ſolar ſyſtem, he begged that he would explain it to him.

That I will with pleaſure, replied the Philoſopher; but firſt let me obſerve to you, that of theſe heavenly bodies ſome are *luminous*, and lend us their own light, as doth the *Sun* and *Fixed Stars*; while others are *opaque*, and have no light of their own to give us; but reflect to us a part of the light they receive from the ſun. This is particularly the caſe with reſpect to the planets and comets of our ſolar ſyſtem, which all give us a portion of the light they have received, and we in return reflect to them a portion of ours: for I make no doubt, but thoſe who inhabit the moon have as much of the ſun's light reflected to them from the earth, as we have reflected to us from the moon.

The inhabitants of the moon! ſays Maſter *Lovelace*, with ſome emotion, Whither will you lead me? What, are the ſtories that have been told of the Man in the Moon then true?

I don't know what ſtories you have heard, replied the Philoſopher; but it is no extravagant conjecture to ſuppoſe that the moon is inhabited, as well as the earth; though what ſort of inhabitants they are, we on the earth are unable to diſcover. As to my part, I am loſt in this boundleſs abyſs. It appears to me that the ſun, which gives life to the world, is only a beam of the glory of God; and the

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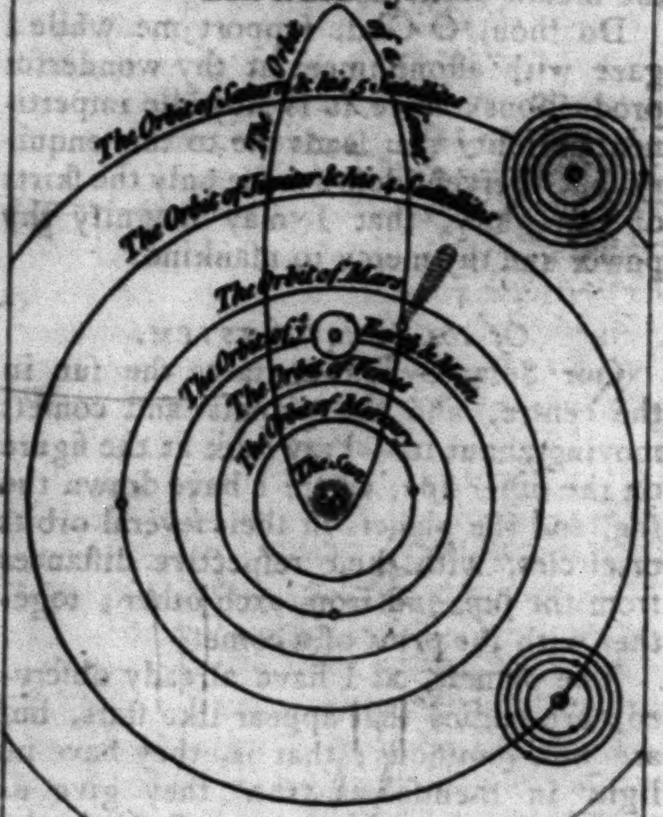
The Solar Syſtem


The Orbit of a Comet
The Orbit of Saturn & his 5 Satellites
The Orbit of Jupiter & his 4 Satellites
The Orbit of Mars
The Orbit of the Earth & Moon
The Orbit of Venus
The Orbit of Mercury
The Sun

air, which ſupports that life, is, as it were the breath of his noſtrils.

Do thou, O God, ſupport me while I gaze with aſtoniſhment at thy wonderful productions; ſince it is not idle impertinent curioſity that leads me to this enquiry, but a fervent deſire to ſee only the ſkirts of thy glory, that I may magnify thy power and thy mercy to mankind.

Of the SOLAR SYSTEM.

Our Solar Syſtem contains the ſun in the centre, and the planets and comets moving about it.---Pray look at the figure on the other ſide, where I have drawn the ſun, and the planets in their ſeveral orbits or circles, with their reſpective diſtances from the ſun, and from each other; together with the orbit of a comet.

The planets, as I have already obſerved, are bodies that appear like ſtars, but are not luminous; that is, they have no light in themſelves, tho' they give us light; for they ſhine by reflecting the light of the ſun. Of theſe there are two kinds, the one called *primary*, and the other *ſecondary* planets.

There are ſix *primary* planets, and theſe are *Mercury*, *Venus*, the *Earth*, *Mars*, *Ju-*

piter, and *Saturn*; all which move round the Sun, as you may ſee in the figure before you; whereas the *ſecondary* planets move round other planets. The *Moon*, you know, (which is one of the ſecondary planets) moves round the *Earth*; four moons, or *Satellites*, as they are frequently called, move round *Jupiter*; and five round *Saturn*. And thus has the Almighty provided light for thoſe regions that lie at ſuch an immenſe diſtance from the Sun.

The amazing diſtance which each planet is at from the Sun, may be ſeen by the time which it takes in its periodical revolution.

Mercury	revolves about the Sun in the ſpace of	88 days.
Venus		225 days.
The *Earth*		365 d. 5h. 49 m.
Mars		one year 322 days
Jupiter		11 years 319 days
Saturn		29 years 138 days

Theſe move round about the Sun from weſt to eaſt in the time above mentioned. They are always to be found among the ſtars of thoſe conſtellations that compoſe the twelve ſigns of the Zodiac; and in their progreſs do not deſcribe a perfect circle, but an orbit a little inclining to an oval: the reaſon whereof I ſhall give you in a future Lecture.

The comets move about the ſun in a long ſlender oval of an amazing extent; one of the focus's being near the centre of the ſun, and the ſhorteſt of the other far beyond the ſphere of *Saturn*; ſo that the periodical revolutions of any are not performed in leſs than 70 or 80 years. See the *Plate*.

But let us quit theſe bodies, of which we know ſo little, and ſpeak of our old companion the moon, with whom we ought to be better acquainted; ſince ſhe not only lights us home in the night, but lends her aid to get our ſhips out of the docks, and to bring in and carry out our merchandize; for without the aſſiſtance of Lady *Luna* you would have no tides: but more of this hereafter.---A little more now, if you pleaſe, ſays *Tom Wilſon*. What then, does the moon pour down water to occaſion the tide? I am at a loſs to underſtand you. No, replied our Philoſopher, the moon does not pour down water to occaſion the tides; that were impoſſible: but ſhe by attracting the waters of the ſea raiſes them higher, and that is the reaſon why the tides are always governed by the moon.

The moon moves round the earth in the ſame manner as the earth does round the ſun, and performs her ſynodical motion, as it is called, in 29 days, 12 hours, and 44 minutes, though the periodical is 27d. 7h. 43m. By this motion of the moon are occaſioned the eclipſes of the ſun and moon, and the different appearances, aſpects, or phaſes ſhe at different times puts on: for when the earth is ſo ſituated between the ſun and the moon, that we ſee all her enlightened parts it is *full Moon*; when the moon is ſo ſituated between the ſun and the earth, that her enlightened parts are hid or turned from us, it is *new Moon*; and when her ſituation is ſuch that only a portion of her enlightened part is hid from us, we ſee a *horned Moon*, a *half Moon*, or a *gibbous Moon*, according to the quantity of the enlightened part we can perceive.

The total or longeſt *Eclipſe of the Moon* happens when the earth is directly between the ſun and the moon, and prevents the light of the ſun from falling upon and being reflected by the moon; as I'll ſhew you. We will ſuppoſe this orange to be the ſun, this cricket-ball the earth, and this top the moon; now if you place them in

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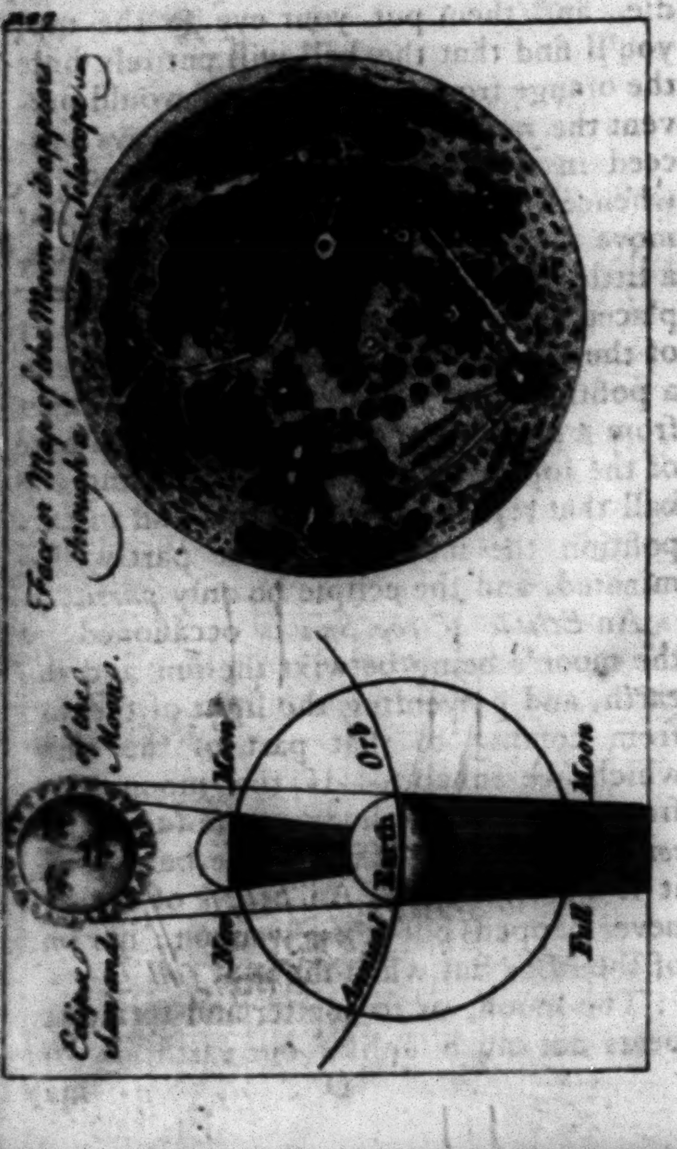
Face or Map of the Moon as it appears through a Telescope
Eclipse of the Sun and of the Moon
New Moon
Full Moon
Earth
Annual Orb

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in a ſtrait line, with the ball in the middle, and then put your eye to the top, you'll find that the ball will entirely hide the orange from your view, and would prevent the rays of light (which always proceed in right lines) from falling upon it, whence would enſue a *total* eclipſe. But move the top, which repreſents the moon, a little on either ſide, and with your eye placed as before you will perceive a part of the orange, which will be now in ſuch a poſition, that a ſtrait line may be drawn from a part of the orange or ſun, to a part of the top or moon, without touching the ball that repreſents the earth; and in this poſition the moon would be partly illuminated, and the eclipſe be only *partial.*

An *Eclipſe of the Sun* is occaſioned by the moon's being betwixt the ſun and the earth, and preventing the light of the ſun from coming to that part of the earth which we inhabit.---If the moon hides from us the whole body of the ſun, it is a *total* eclipſe; but if the whole be not hid, it is a *partial* one. An *Eclipſe* of the *Sun* never happens but at a *new* moon; nor one of the *Moon* but when ſhe is at *full.*

The moon, as to matter and form, appears not much unlike our earth, as you may perceive by this Map. The bright parts are ſuppoſed to be the high illuminned tracts of land, as *mountains*, *iſlands*, &c. and the dark parts it is imagined are the *ſeas*, *lakes*, and *vales*, which reflect but little light. But of this there is no certainty.

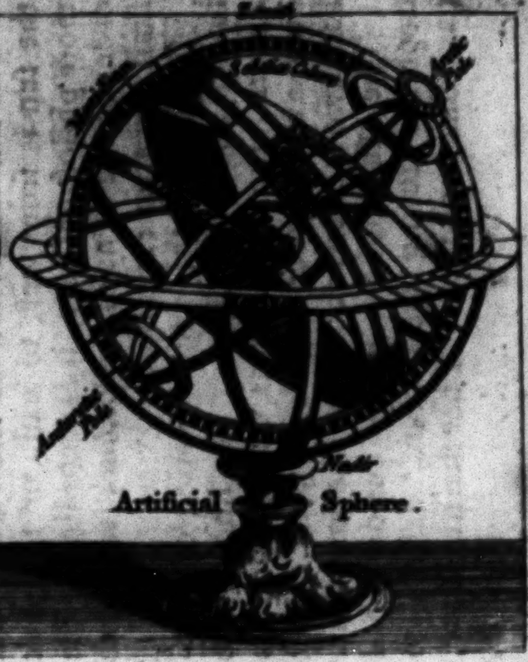
The *Earth*, by its revolution about the ſun in 365 days, 5 hours, and 49 minutes, meaſures out that ſpace of time which we call a *Year*; and the line deſcribed by the earth in this annual revolution about the ſun is called the *Ecliptic*. To give you a perfect idea of this and other circles neceſſary to be known, I have on the oppoſite ſide preſented you with the figure of a Sphere.

The annual motion of the earth round the ſun is from weſt to eaſt, or to ſpeak more philoſophically, it is according to the order of the ſigns of the *Zodiac*; which we ſhall hereafter explain.

But beſides this annual motion or revolution about the ſun in the line of the *Ecliptic*, the earth turns round upon its own axis in about 24 hours; ſo that it hath two motions at one and the ſame time.

The Marchioneſs, whoſe curioſity had kept her during the Lecture, deſired to have this explained. That ſhall be done, Madam, p.38

The Terrestrial Globe.



Artificial Sphere.

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Madam, in a minute, ſays the little Philoſopher, and I can never have a better opportunity; for I ſee the Duke of *Galaxy* is coming to make your Ladyſhip a viſit. His coach is juſt entering the iron gates, and will preſently wheel round the circle, or rather oval, before the portico. Pray, Madam, fix your eye on one of the wheels, which you may do as it is moon-light, and you will perceive it turn round upon its own axis, at the ſame time that it runs round the circle before the houſe. This double motion of the wheel very fitly repreſents the two motions of the earth, which have heretofore been explained by the motion of a bowl on a bowling-green; but I believe your Ladyſhip will think the inſtance or example before us is better. It is hard to reaſon from ſimilitudes, becauſe they generally fail in ſome part: all the members of a ſimile ſeldom correſpond with the ſubject it is intended to illuſtrate; and, if I miſtake not, that is the caſe with the bowl upon the green; which, though it aptly repreſents the earth's motion on its own axis, is far from repreſenting its revolution about the ſun, becauſe the bias in the bowl will never induce it to form either a circle or an oval; for the figure it deſcribes is rather a parabola, or that ſort of figure which a long fiſhing-rod forms when it is bent by drawing a fiſh out of the water.

Your Ladyſhip knows perfectly that the earth turning on its own axis makes the difference of day and night: you will therefore give me leave, Madam, to addreſs my diſcourſe to theſe young gentlemen and ladies, who may be ignorant of this branch of Philoſophy.

That the turning of the earth on its own axis makes the difference of *day* and *night* is moſt certain; for in thoſe parts of the earth which are turned towards the ſun it will be *day*, and of conſequence it muſt be *night* in thoſe which are turned from it.

But the length of *days* and *nights*, and the variation of the *ſeaſons*, are occaſioned by the annual revolution of the earth about the ſun in the *Ecliptic*; for as the earth in this courſe keeps its axis equally inclined every where to the plane of the Ecliptic and parallel to itſelf, and as the plane of the Ecliptic inclines 23 degrees and a half towards the the Equator, the earth in this direction has ſometimes one of its poles neareſt the ſun, and ſometimes the other. Hence heat and cold, ſummer and winter, and length of days and nights. Yet notwithſtanding theſe effects of the ſun, which gives us light and heat, his diſtance from us is ſo great, that a cannon-ball would be 25 years coming thence to the earth, even if it flew with the ſame velocity as it does when it is firſt diſcharged from the mouth of a cannon.

Here they were all amazed, and Lady *Caroline* ſaid this doctrine could not be true; for if the ſun was at that immenſe diſtance, his light could not reach us every morning, in the manner it does.---I beg your pardon, Madam, replied the Philoſopher; your Ladyſhip's miſtake ariſes from your not knowing, or at leaſt not conſidering, the amazing velocity of light; which flies after the rate of 200,000 miles in a *ſecond* of time; ſo that notwithſtanding a cannon-ball would be 25 years in coming from the ſun, the light finds its way to us in about eight minutes. But if you are ſo ſurprized at the ſun's diſtance, Madam, what think you of that of the fixed ſtars, which are ſo far remote from us, that a cannon-ball, flying with the ſame velocity as when firſt diſcharged, would be 700,000 years in coming to the earth?

earth! Yet many of theſe ſtars are ſeen, and even without the uſe of teleſcopes.

There are other things obſervable in our Solar Syſtem, which if attended to will excite our admiration: ſuch are the dark ſpots which are ſeen on the *Sun's* ſurface, and which often change their *place*, *number*, and *magnitude*. Such alſo is the amazing Ring wich encompaſſes the body of the planet *Saturn* at the diſtance of 21,000 miles; and ſuch are the Belts that gird the body of *Jupiter*: concerning all which there are various conjectures, but conjectures in Philoſophy are rarely to be admitted.

LECTURE III.

Of the AIR, ATMOSPHERE, *and* METEORS.

WHAT was ſaid by the Marchioneſs and Lady *Caroline* in favour of Maſter *Teleſcope* excited the Duke of *Galaxy*'s curioſity to ſee him, and the next morning he came into the Obſervatory juſt as the Lecture began. The preſence of ſo great a perſonage as the Duke put our young gentlemen into ſome confuſion, and ſeveral of them offered to go away; which the Duke obſerving ſtepped into the next room, and Maſter *Teleſcope* took this opportunity to correct their folly.

Gentlemen, ſays he, I am amazed at your meanneſs and ill-manners. What, becauſe the Duke does you the honour of a viſit, will you run away from him? There is nothing betrays a mean ſpirit and low education ſo much as this ridiculous awe and dread which ſome people ſhew in the company of their ſuperiors; and beſides, it is troubleſome; for the uneaſineſs that one perſon is in communicates itſelf to the reſt of the company, and abridges them of a portion of their pleaſure. The eaſier you appear in the company of the Great, the more polite you will be eſteemed. None but a clown hangs down his head, and hides his face; for a gentleman always looks in the face of his ſuperior when he talks to him, and behaves with openneſs and freedom. As to my part, I venerate his Grace; but then it is for his great worthineſs of character, which has engaged my affection, and inclines me to wiſh for his company, not to avoid it. *Civility we owe to every one*, and *Reſpect* is due to the Great: it is claimed, and it is given, in conſequence of their ſuperior birth and fortune; but that is all; for our affection is only to be obtained by worthineſs of character. Birth and fortune are merely accidental, and may happen to be the portion of a man without merit; but the man of genius and virtue is enobled, as it were by himſelf, and is honoured not ſo much for his grandfather's greatneſs as his own. This reproof had its proper effect; for they all ſat down, and his Grace being returned, with Lady *Caroline*, our Philoſopher began his Lecture on the nature and properties of the *Air*, *Atmoſphere*, and *Meteors* contained therein.

We have already conſidered the earth as a planet, ſays he, and obſerved its diurnal and annual motion; we are now to ſpeak of the materials of which it is compoſed, and of the Atmoſphere, and the Meteors that ſurround and attend it.

In order to explain theſe effectually, ſays the Duke, you ſhould, I think, Sir, begin with an account of the firſt principles or four Elements, which are *Fire*, *Air*, *Earth*, and *Water*, and then ſhew how they affect each other, and by their mutual aid give motion, life and ſpirit to all things; for without fire the water would aſſume a different form, and become ſolid ice; without water the fire would ſcorch up the earth, and deſtroy both animals and plants. Without air, the fire perhaps would be unable to execute its office, nor withour air could the water, tho' exhaled by the ſun into clouds, be diſtributed over the earth for the nouriſhment of plants and animals. Nor is the earth inactive but lends her aid to the other elements. She filtres, or ſtrains and purifies the ſalt water which runs from the ſea, and makes it freſh and fit for the uſe of animals and plants; and by reflecting the ſun's beams occaſions that warmth which nouriſhes all things on her ſurface; but which would be very inconſiderable and ſcarcely felt if a man was placed on the higheſt mountain, above the common level of the earth, and in ſuch a ſituation as to be deprived of her reflection.

All this, my Lord Duke, I have conſidered, replied the Philoſopher, and had thoughts of carrying it farther, and ſhewing how thoſe elements pervade and are become indeed conſtituent parts of the ſame body; for *Fire*, *Air*, *Earth*, and

Water are to be drawn even from a dry ſtick of wood. That two ſticks rubbed violently together will produce fire is very well known; for coach or waggon wheels frequently take fire when not properly clouted with iron, and ſupplied with greaſe: And if pieces of wood, ſeemingly dry, be put into a glaſs retort over a furnace, you'll obtain both air and water, and then if you burn the wood to aſhes, and waſh out the ſalts with water, as the good women do when they make lye, the remaining part will be pure earth: And thus we can at any time draw the four elements out of a ſtick of wood. But as theſe ſpeculations are above the comprehenſion of ſome of the young gentlemen whom I have the honour to inſtruct, I ſhall defer the conſideration of ſuch minute and abſtruſe matters till another opportunity. Science is to be taught as we teach children the uſe of their legs, they are at firſt ſhewn how to ſtand alone, after this they are taught to walk with ſafety, and then ſuffered to run as faſt as they pleaſe; and I beg your Grace will permit me to purſue this method in the courſe of my Lectures. The Duke gave his aſſent with a nod, and our Philoſopher thus proceeded.

The air is a light, thin, elaſtic or ſpringy body, which may be felt but not ſeen; it is fluid and runs in a current like water, (as you may perceive by opening the window) but it cannot, like water, be congealed into ice; and the Atmoſphere is that great body or ſhell of air, which ſurrounds the earth, and which reaches many miles above its ſurface, as is known by conſidering the elaſticity, or ſpringineſs of the air and its weight together; for a column of air is of equal weight to a column of quickſilver of between 29 and 30 inches high; now quickſilver being near fourteen times heavier than water, if the air was as heavy as water, the Atmoſphere would be about fourteen times higher than the column of quickſilver, or about 34 feet; but the air is near 1000 times lighter than water, therefore the Atmoſphere muſt be many miles high, even at this rate of computing: And when with this you conſider the elaſticity of the air, which when the preſſure of the incumbent Atmoſphere is taken off, will dilate itſelf ſo as to fill more than 150 times the ſpace it occupied before, you will perceive that the height of the Atmoſphere muſt be very great.

For as the air is a ſpringy body, that part next the earth muſt be more denſe than the upper part, as being preſſed down by the air above it. Look at that hay-ſtack yonder, which the groom is cutting, and you'll perceive that the hay at bottom is much cloſer and harder to cut than that at the top, becauſe it has been preſſed into leſs ſpace than it otherwiſe would have occupied, by the other hay above it; and had not the whole ſtack been trodden and preſſed down by the man who made it, the difference would have been ſtill more conſiderable.

The air, however, even near the earth, is not always in the ſame ſtate. It is ſometimes rarified, and becomes lighter than at other times, as appears by the quickſilver's falling in the Barometer, and the rain's deſcending on the earth; for it is the denſe ſtate or weight of the air which raiſes the quickſilver in the Barometer, the water in the pump, and prevents the clouds from falling down in rain.

This elaſtic principle in the air, which renders it ſo capable of being rarified and condenſed, has been productive of the moſt wonderful effects. But before you proceed farther, ſays Lady *Caroline*, pray do me the favour, Sir, to convince me, by ſome experiment that the air is endowed with this wonderful quality. That he cannot do, replied the Duke, without the uſe of proper inſtruments. Almoſt any thing will do, an't pleaſe your Grace, ſays the Philoſopher.--LittleMaſter's *Pop-gun*, that lies in the window, is ſufficient for my purpoſe.---Do me the honour to ſtep this way, Lady *Caroline*. You ſee here is a pellet in the top of this tube, made of hemp or brown paper. With this piece of paper we will make another pellet, and put into the other end. Now with the gun-ſtick drive it forward. There, you have forced the pellet ſome part of the way with eaſe, but it will be more difficult to get it farther, becauſe the air, being compreſſed, and made more denſe or compact will make more reſiſtance; and when you have preſſed it ſo cloſe that its force overpowers the reſiſtance which the pellet makes at the other end, that pellet will fly off with a bounce, and be thrown by the ſpring of the air to a conſiderable diſtance.---There, ſee with what force it is thrown.

This you have taken little notice of, becauſe it is a ſchool boy's action, and is ſeen every day; for indeed, we ſeldom trouble ourſelves to reaſon about things that are ſo familiar; yet on this principle, my Lady, depends the force of a cannon; for it is not the gunpowder and fire that drives out the ball with ſuch prodigious velocity; no, that force is occaſioned by the fire's ſuddenly rarifying the air, which was contained in the chamber or breach of the cannon, and that generated by the powder itſelf. As a proof of this, place the ſame ball, in the ſame quantity of powder in an open veſſel, and when fired you will ſcarce ſee it move. But there have been guns lately invented, called wind-guns, which abundantly prove what I have advanced; for they are charged only with concentrated or condenſed air and with ball, yet ſo contrived, that ſix or ſeven balls may be let off, one after the other, each of which would kill a buck or a doe at a very conſiderable diſtance.

You ſeem all amazed, and I don't wonder at it, ſince you have never yet conſidered the extraordinary properties of this element; and it muſt ſeem ſtrange to you that the air, which is ſo neceſſary for life, that without it we cannot breathe, ſhould be tortured into an inſtrument of deſtruction. You will however be more ſurprized when I tell you, that this is the cauſe of earthquakes; and that the noble city of *Liſbon* was lately deſtroyed by a ſudden rarifaction of the air contained in ſome of the caverns of the earth, and perhaps under the ſea. *Tom Wilſon* gave a leer of impertinence, but was aſhamed to ſhew his folly before ſuch good company. All the reſt ſtared at each other without ſpeaking a word, except Lady *Caroline*, who proteſted ſhe could not believe what he had ſaid about earthquakes; for, ſays ſhe, I remember to have read in the News Papers, that the flames burſt out of the ground. That might be, my Lady, ſays the little Philoſopher, for there could be no ſuch ſudden rarifaction of the air without fire. Fire, therefore, did contribute towards the earthquake, and fire might burn down a mountain compoſed of combuſtibles; but fire could never blow one up. No, my Lady, that effect is the ſole property of the air. This diſpute would, in all probability, have taken up much time; but

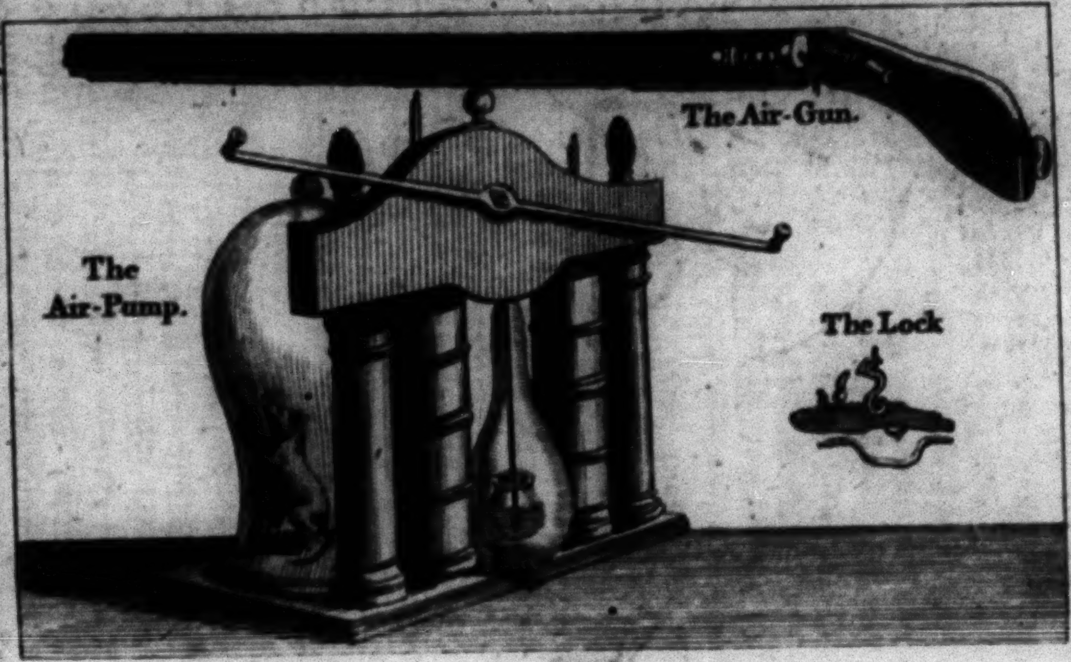
his

his Grace put an end to the controverſy, by declaring it was true Philoſophy.

In this property of being rarified and condenſed, the air differs amazingly from water, which tho' compoſed of ſuch ſmall particles as not to be diſtinguiſhed or ſeen ſeparately with a microſcope, and its readineſs to riſe or be evaporated with heat, and to be ſeparated with a touch, cannot when confined, be at all concentrated or brought into a leſs compaſs. This experiment was once tried, by filling a golden globe full of water, then cloſing it up, and placing it in a ſcrew preſs, which was pulled down with great force. In this ſituation it remained till the water ſweated thro' the pores of the gold, and till that happened it would never give way.

Air is the medium which diffuſes light to the world; for if there was no Atmoſphere to refract the ſun's rays round the globe, it would be almoſt as dark in the day time as in the night, and the *Sun*, *Moon*, and *Stars*, would only be viſible. It is alſo the medium of ſounds, which are conveyed by the tremulous motion of the air when agitated by any noiſe. Let me throw this peach ſtone into the moat, and you will perceive circles of ſmall waves diffuſe themſelves by degrees to a great diſtance round it. Now as the air is fluid as well as the water, we may conclude that ſound is conveyed ſomewhat in this manner, tho' as that is nearly a thouſand times lighter than water, ſounds are propagated at an amazing rate, ſome ſay after the rate of 1142 feet in a ſecond of time; but, however that be, we may reſt aſſured, that ſound is conveyed in this manner. Only throw up the ſaſh, and halloo, and the echo, which I ſpoke of in the beginning of the ſecond Lecture, will return you the ſound; that is, the waves or pulſes of air, which are put in motion by the noiſe you make, will ſtrike againſt the rocks, and return to you again; for echo is nothing but the *reverberation* of ſound: and that there can be no ſound conveyed without air, is proved by experiment; for a bell ſtruck in an exhauſted receiver in an air pump, cannot be heard, that is, it has little or no ſound.

Without air there would be no merchandize, for your ſhips could not ſail to foreign climates; and without air the birds could not fly, ſince they would have nothing to ſupport them, and their wings would be uſeleſs; for we know, that a feather falls with as much velocity as a guinea in an exhauſted receiver. But above all, air is the principle which preſerves life, both in plants and animals; there is no breathing without air, and you know, when our breath is ſtopt we die. This is one of thoſe truths that are called ſelf-evident, becauſe it is univerſally known, and needs no confirmation; but if demonſtration be thought neceſſary you may have it in a minute, by putting ſome living creature into the air pump; but it is cruel to torture a poor animal: So ſaid Lady *Caroline*, and violently oppoſed this experiment's being tried; but as all the reſt were for it, the Duke was willing to gratify their curioſity; and therefore told our Philoſopher, that he might try the experiment with a rat, which they had caught in a trap, and if he ſurvived it, give him his life for the pain they had put him to. This creature was accordingly put in the receiver, and when the air was partly exhauſted, he appeared in great agony, and convulſed; and more air being pumped out,


The Air-Gun.
The Air-Pump.
The Lock

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he fell on his ſide for dead; but freſh air being immediately admitted, it ruſhed into his lungs, which put them in motion again, and he recovered. The manner of the animal's recovery puts me in mind, ſays the Philoſopher, of an accident which I once ſaw, and which I would have you all remember, for it may be of ſervice to mankind.

Some time ago I was bathing, with ſeveral of my ſchool-fellows, in a river by the road-ſide. Maſter *Curtis*, who was an obſtinate ſilly boy, would daſtard the reſt, as he called it; that is, he would fooliſhly exceed them in running into dangers and difficulties, and with this view, tho' he could ſwim no more than a ſtone, he plunged into a part of the river, which we told him was greatly above his depth, where he roſe, and ſtruggled to get out, but could not. We were all, you muſt imagine, in the utmoſt diſtreſs, and unable to aſſiſt him; for none of us could ſwim. At this inſtant came by ſome Gentlemen on horſeback, who immediately diſmounted, and got him out, but not till after he had ſunk the third time. He was brought to ſhore without ſigns of life, and blooded without any effect; when one of the Gentlemen, who I have ſince heard was a great Philoſopher, adviſed them to blow ſome air down his throat; this was done, and the elaſticity of the air put his lungs in motion, as I imagine, for a pulſation immediately enſued, and he recovered almoſt as ſoon as this animal. Now, from what I heard that Gentleman ſay, and from the inſtance before us, there is reaſon to believe, that the lives of many might be ſaved, who are ſuppoſed drowned, if this method was put in practice of conveying air to the lungs; for you are to conſider, that unleſs the lungs are in motion, there can be no circulation, and it was for want of air, that their motion ceaſed in the water. Pray, Gentlemen, let this be remembered, for it is a matter of great importance.

We are to obſerve, Gentlemen, that air which has paſt thro' fire, or is become foul, or ſtagnated, and has loſt its ſpring, is unfit for reſpiration. It was the want of freſh air, or, in other words, the being obliged to breathe air that was foul, and had loſt its ſpring, or elaſtic force, that killed ſo many of our poor country-men in the black hole at *Calcutta*, in the *Eaſt Indies*, as you have ſeen by the News Papers; and this breathing of foul air in inflammatory, putrid, and eruptive diſorders, ſuch, for inſtance, as the ſmall-pox, and ſome fevers, has deſtroyed more than can be imagined. If therefore you ſhould be ſeized with any of theſe diſorders, adviſe the people about you to make uſe of their common ſenſe, and not, becauſe a man is ill, deprive him of that vital principle the air, without which he could not live, even in a ſtate of health. Never ſuffer your curtains to be drawn cloſe, or exclude the freſh air, even when you ſleep.

I am greatly miſtaken, ſays Lady *Caroline*, if the air we are now in has not loſt its ſpring; for I breathe with difficulty. Was that the caſe, Madam, replied the little Philoſopher, you would not be able to breathe at all; but if your Ladyſhip finds the air ſo diſpoſed, you ſhould make uſe of the inſtrument that lies by you, which, by putting the air in motion, will in part recover its ſpring. What inſtrument, Sir? ſays the Lady. Your fan, Madam, returned the Philoſopher. Every ſan is a philoſophical inſtrument, and was originally contrived, we may ſuppoſe, for the purpoſe above-mentioned.

A bird dying in an Air-pump will be in ſome meaſure recovered by the convulſive fluttering of its own wings, becauſe that motion alters the ſtate of the air remaining in the receiver, and for a time renders it fit for reſpiration.

Motion is the only preſervative for air and water; both of which become unwholſome if kept long in a ſtate of reſt; and both may be recovered and made ſalutary by being again put into motion.

If foul and ſtagnated air has ſuch dire effects, how much are we obliged to the learned and ingenious Dr. *Hales* for diſcovering the *Ventilator*, an inſtrument which, in a little time, diſcharges the foul air from ſhips, priſons, and other cloſe places, and ſupplies them with that which is freſh?

The air, by ſome Philoſophers, has been eſteemed an univerſal *menſtruum*, becauſe, ſay they, it diſſolves all bodies in time, and reduces their ſubſtances to a new form; as iron into ruſt, copper into verdigreaſe, &c. but this, I am inclined to think, is not ſo much owing to the air as to certain ſaline or acid particles, which the air extracts from ſome bodies, and which afterwards cleave to other bodies, with which they have a cloſer affinity than with the air itſelf. But this I ſhall endeavour to explain in a future work.

We are now to ſpeak of the Wind, which is only a ſtream or current of air, as a river is of water, and is occaſioned by heat, eruptions of vapours, condenſations, rarifactions, the preſſure of clouds, the fall of rains, or ſome other accident that diſturbs the equilibrium of the air; for Nature abhors a vacuum, and for that reaſon, when the air is extremely rarified in one part, that which is more denſe will immediately ruſh in to ſupply the vacant places, and preſerve the equilibrium; as is the caſe with water and other fluid ſubſtances. Only raiſe a veſſel of water ſuddenly out of a ciſtern, and ſee with what ſpeed the other water will ruſh in, to fill up the ſpace and preſerve its level. And theſe rarefactions in the air may happen near the earth, or much above it, and is the reaſon why clouds fly in contrary directions. This occaſioned the loſs of the great *Kite*, which we were a whole fortnight in making; for, tho' there was

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ſcarcely wind in the Park ſufficient to raiſe it, yet when lifted extremely high by the air, it was ſeized by a current of wind and torn in pieces.

Winds are violent, or gentle, in proportion to the rarifaction or diſturbance there has been in the atmoſphere. A violent wind in a great ſtorm, flies after the rate of 50 or 60 miles in an hour, and is often ſo denſe, or ſtrong, as to bear down trees, houſes, and even churches before it. What the ſailors call a briſk wind flies after the rate of about 15 miles an hour, and is of great uſe in cooling the air, and cleanſing it from poiſonous and peſtilentious exhalations.

The winds have various qualities, they are generally hot or cold, according to the quarter from whence they blow. I remember, ſome years ago, we had a South-Weſt wind in *February*, which blew ſo long from that quarter, that it brought us the very air of *Liſbon*, and it was as hot as in ſummer. Winds from the North and North-Eaſt, which come off large tracts of land, are generally cold. Some winds moiſten and diſſolve, others dry and thicken; ſome raiſe rain, and others diſperſe it: Some winds blow conſtantly from one quarter, and are therefore called the *general Trade Winds.* Theſe are met with on each ſide of the *Equator*, in the *Atlantic*, *Ethiopic*, and *Pacific Oceans*, between the Tropicks, and to near 24 degrees of latitude; and are occaſioned by the Sun in his rotation round his axis, agitating the æther, or by the rarifaction of the air by the ſolar rays, and the denſer air continually pouring in from the diſtant parts of each hemiſphere to maintain the equilibrium. Some winds, again, blow conſtantly one way for one half, or one quarter of the year, and then blow the contrary way. Theſe are met with in the *Eaſt-Indian Seas*, and are called *Monſoons*, or periodical Trade Winds. But as theſe ſubjects are abſtruſe and difficult, and afford little entertainment, we ſhall defer an explanation of them till our next courſe of Lectures, and endeavour to give you ſome account of the Meteors that attend the air.

We have already obſerved, that beſides pure air, the atmoſphere contains minute particles of different ſorts, which are continually ariſing in ſteams from the earth and waters, and are ſuſpended and kept floating in the air.

The moſt conſiderable of theſe are the

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ſmall particles of water, which are ſo ſeparated as to be lighter than air, and are raiſed by the Sun's heat, or lifted up by the wind from the ſea, rivers, lakes, and marſhy or moiſt parts of the earth, and which deſcend again in *Dews*, *Rain*, *Hail*, and *Snow*.

When theſe ſmall particles are by a rarified ſtate of the air ſuffered to unite many of them together, and deſcend ſo as to render the hemiſphere more opaque, and by its humidity to moiſten bodies on the Earth, it is called a *Miſt*. And on the contrary, thoſe particles of water that ariſe after a hot day from rivers, lakes, and marſhy places, and by filling the air moiſten objects, and render them leſs viſible, are called *Fogs*.

Clouds are the greateſt and moſt beneficial of all the *meteors*, for they are borne about on the wings of the wind, and, as the Pſalmiſt obſerves, *diſtribute fatneſs to the Earth*. Clouds contain very ſmall particles of water, which are raiſed a conſiderable diſtance above the ſurface of the earth; for a cloud is nothing but a miſt flying high in the air, as a miſt is nothing but a cloud here below.

That theſe vapours are raiſed in the air, in the manner abovementioned, may be readily conceived; for it is an action that is ſeen every day in common diſtillations; but how theſe inviſible particles, which float in the air, are collected into clouds in order to bring the water back again, is not ſo eaſy to determine. Perhaps, ſays the Marchioneſs, who had juſt before entered the room, it may be occaſioned by the winds driving the clouds together and uniting the particles, which may by that means become ſpecifically heavier than the the air, and therefore fall down. There is reaſon, my Lady, in what you ſay, replied the Philoſopher, but I would wiſh to know how theſe clouds are ſometimes all of a ſudden collected. It frequently happens, Madam, that you go abroad when the ſky is ſo ſerene and clear, that not a cloud is to be ſeen, and before your Ladyſhip has taken a turn round the *Park*, you ſhall ſee clouds gather round, and all the hemiſphere overcaſt, and the drops begin to fall. How happens this? There were no clouds for the winds to drive againſt each other, nor could the aqueous vapours ariſe from the Earth, and deſcend at the ſame inſtant of time. Whence then could they come? I am afraid, Madam, ſays the

Duke, this young Gentleman has ſhaken your Ladyſhip's Philoſophy; for the queſtion he has put is not to be anſwered without ſome knowledge of Chemiſtry, which is, I think, too little ſtudied in this kingdom. I am not uneaſy about it, my Lord Duke, ſays the Marchioneſs, he is the Lecturer, and let him account for it if he can.---I ſhall get little honour by ſolving this queſtion, ſays the Philoſopher, ſince his Grace has pointed out the only method, by which it can be done, that is to ſay, by Chemiſtry; for that action of bodies which the Chemiſts call *precipitation*, will anſwer it in all reſpects; but the explanation of it is a taſk ſo difficult, that I muſt defer it till another opportunity. Some idea, however, I will endeavour to give theſe young Gentlemen of precipitation, if your Ladyſhip will favour me with the tincture of bark which I ſaw in your hand this morning. The bark, Gentlemen, at leaſt the reſinous part of the bark, is here ſuſpended in ſpirits of wine; and ſo ſuſpended that you ſee it is perfectly bright. Now in order to precipitate this bark, I muſt find out a body which has a cloſer affinity or relation with the ſpirits of wine, than the bark has (for things inanimate have all their relations when chemically conſidered ;) that body is water, which when I add to the tincture, you will perceive it grow foul ; for the ſpirits of wine will immediately let go the bark to lay hold of the water, which will occupy the ſpace the bark before filled, and that will fall to the bottom. This perhaps may be the caſe in the atmoſphere ; ſome ſubſtance may be brought into the air, to which it is nearer allied than to the water, that it ſuſpended before in ſuch a pellucid manner, as not to be ſeen, but which water becomes obvious, when the air lets it go to embrace its nearer ally, and by uniting firſt into ſmall drops, then into larger, becomes too heavy to be ſuſpended by the air, and falls down in *rain*.

But all clouds are not compoſed of watery vapours only ; they are ſometimes impregnated with ſulphureous and even ſaline particles, which are exhaled from the earth ; for the Chemiſts will tell you by experience, that volatile bodies will volatilize ſome fixed bodies, and carry them off : And this happens to be the caſe here, as may be particularly ſeen in *Thunder* and *Lightning*, which is occaſioned, we may ſuppoſe, by the ſulphureous and nitrous particles taking fire, and burſting the cloud with a tremendous noiſe, which is preceded by a flaſh of fire, much reſembling that of lighted *gun-powder*, only more penetrating, which is owing, perhaps, to its extreme volatility. ---But look, there is a cloud riſing before us, which ſeems replete with that electrical matter, and may by and by diſcover, in a more ſenſible manner, thoſe effects to you which I have been endeavouring to deſcribe.

That there are ſome ſort of nitrous particles, or a ſubſtance very much like it raiſed in the air, is, I think, evident, from that nouriſhment which rain (and particularly that rain which is attended with thunder) gives to vegetables, above common water; and from the quantities of nitre which have been found in heaps of earth that were expoſed to the air, at the ſame time that it was kept from the rain.

Snow ſeems to be the ſmall particles of water frozen in the air before they had united into drops, and *hail* ſeems to be drops of rain frozen in their fall. From the regular figures which *ſnow* and *hail* put on in their deſcent, ſome have been inclined to think, that they contain particles of ſalt mixed with the water, and which occaſioned them to ſhoot and unite in certain angles; but an experiment ſhould, I think, be tried before this is admitted as true Philoſophy, and it might be done by boiling the ſnow and hail over the fire, till it put on a pellicle or ſcum at the top, and then ſetting it in a cold place, for the ſalts to cryſtallize, or ſhoot to the bottom.

"I know nothing of Cryſtallizations, ſays Lady *Caroline*, nor ſhall I ever turn Chemiſt; therefore, good Sir, give us ſomething more entertaining. Pray can you tell me what occaſioned thoſe terrible lights in the air which we had laſt week."

The *Aurora Borealis*, or northern lights, ſays he, are occaſioned, Madam, by certain *nitrous and ſulphureous vapours*, which are thinly ſpread through the atmoſphere above the clouds, where they ferment, and taking fire, the *exploſion* of one portion kindles the next, and the flaſhes ſucceed one another, till all the vapour is ſet on fire, the ſtreams whereof ſeem to converge towards the zenith of the ſpectator, or that point of the heavens which is immediately over his head.

At this inſtant up ſtarted Maſter *Long*, and told her Ladyſhip, if ſhe had done, he would be glad to aſk a queſtion: Sir, ſays ſhe, with a ſmile, it was you made the compliment, I ſhould be glad to hear your queſtion, for, I dare ſay, it will be a ſenſible one. I wiſh you may find it ſo, replied he; but what I want to have an account of, is this ſame *Jack with a Lanthorn*, which ſo haunts my Lord Marquis's park, and t'other day led my friend *Tom Wilſon* into a large pond. Maſter *Wilſon*, you are to underſtand, had been at his uncle's, where he ſtaid rather too late, and therefore his uncle ordered the Footman to light him home; but *Tom* being a very courageous fellow, and a little obſtinate, would walk home alone, and in the dark; but juſt as he came into the marſhy meadow, who ſhould he almoſt overtake but this ſame Gentleman, this *Jack with the Lanthorn*, who he miſtook for Goody *Curtis*, the chare-woman, and thought ſhe was lighting herſelf home from work. *Tom* ran to overtake Dame *Curtis*, but Mr. *Jack with his Lanthorn* ſtill kept out of reach, and led my friend *Tom* out of the path, which he did not perceive till he had loſt himſelf; on which *Tom* ran, and *Jack* ran; *Tom* halloo'd, and *Jack* would not anſwer; at laſt ſouſe came *Tom* into *Duckweed Pond*, where he might have lain till this time, if Mr. *Goodall* had not heard him call out as he was riding by, and ran to his aſſiſtance. This put all the company in good humour, and *Tom* had good nature and good ſenſe enough to join them in the laugh, which being ſubſided, our Philoſopher thus proceeded in his Lecture.

The *Ignis Fatuus*, *Jack with a Lanthorn*, or *Will with the Wiſp*, as it is frequently called, ſays he, is ſuppoſed to be only a *fat*, *unctuous*, and *ſulphureous vapour*, which in the night appears lucid, and being driven about by the air near the earth's ſurface, is often miſtaken for a light in a lanthorn, as my friend Maſter *Wilſon* can teſtify. Vapours of this kind are in the night frequently kindled in the air, and ſome of them appear like falling ſtars, and are by ignorant people ſo called.

It may be here neceſſary to mention that beautiful phenomenon the Rainbow, ſince it has the appearance of a meteor, though, in reality, it is none; for the Rainbow is occaſioned by the refraction or reflection of the ſun's beams from the very ſmall drops of a cloud or miſt ſeen in a cera certain angle made by two lines, the one drawn from the ſun, and the other from the eye of the ſpectator, to thoſe ſmall drops in the cloud which reflect the ſun's beams: ſo that two perſons looking on a Rainbow at the ſame time, do not, in reality, ſee the ſame Rainbow.

There are other appearances in the atmoſphere which ought to be taken notice of, and theſe are the halo's, or circles, which ſometimes ſeem to encompaſs the ſun and moon, and are often of different colours. Theſe always appear in a *rimy* or *froſty* ſeaſon, and are therefore, we may ſuppoſe, occaſioned by the refraction of light, in the frozen particles in the air.

Here the Lecture would have ended, but a ſudden clap of thunder brought on freſh matter for meditation; ſome of the company, and particularly the Ladies, endeavoured to avoid the lightning; but Maſter *Teleſcope*, after the ſecond clap, threw up the ſaſh, and aſſured the Ladies and Gentlemen there was no danger, for that the clouds were very high in the air. The danger, in a thunder-ſtorm, ſays he, is in proportion to the violence of the tempeſt, and the diſtance of the clouds; but this tempeſt is not violent, and that the cloud is at a great diſtance, or high in the air, you may know by the length of time there is between your ſeeing the flaſh of lightning, and hearing the clap of thunder. Look, ſee how the ſky opens, to emit the fire, preſently you will hear the thunder; for you know we ſee the fire from a gun at a diſtance long before we hear the report! There it is! and how tremendous! Theſe tempeſts always put me in mind of that beautiful paſſage in *Shakeſpear's King Lear*; where when the good old King is out in a ſtorm, and obliged to fly from his unnatural children, he ſays,

————Let the great gods,
That keep this dreadful thund'ring o'er our heads,
Find out their enemies now. Tremble, thou wretch,
That haſt within thee undivulged crimes
Unwhipt of juſtice! Hide thee, thou bloody hand;
Thou perjur'd, and thou ſimular of virtue,
That art inceſtuous! Caitiff, ſhake to pieces,
That under covert and convenient ſeeming
Has practis'd on man's life! Cloſe pent-up guilt,
Rive your concealing continents, and aſk
Theſe dreadful ſummoners grace!—

This tempeſt will not give me leave to ponder
On things would hurt me more——

Poor naked wretches, whereſoe'er you are,
That bide the pelting of this pitileſs ſtorm!
How ſhall your houſeleſs heads, and unfed ſides,
Your loop'd and window'd raggedneſs, defend you
From ſeaſons ſuch as theſe?—O, I have ta'en
Too little care of this: Take phyſic, pomp!
Expoſe thyſelf to feel what wretches feel,
That thou may'ſt ſhake the ſuperflux to them,
And ſhew the Heav'ns more juſt.

LECTURE IV.

Of MOUNTAINS, SPRINGS, RIVERS, *and the* SEA.

WE come now, ſays the Philoſopher, to the conſideration of things with which we are more intimately acquainted, but which are not, on that account, the leſs wonderful. How was that Mountain lifted up to the ſky? How came this cryſtal Spring to bubble on its lofty brow, or that large River to flow from its maſſy ſide? But above all, how came this mighty body of water, the Sea, ſo collected together; and why and how was it impregnated with ſalt, ſeeing the fiſh and other animals taken out of it are perfectly freſh? Theſe are queſtions not to be anſwered even by the Sages in ſcience. Here the Philoſopher, at the end of his judgment, and loſt in admiration, can only ſay with the Pſalmiſt, *They that go down into the Sea, and occupy their buſineſs in the great waters, theſe men ſee the greatneſs of God, and his wonders in the deep.* Wonderful are thy works, O Lord, in judgment haſt thou made them all!---The earth is full of thy greatneſs!

It is the buſineſs of philoſophy, however, to enquire into theſe things, tho' our enquiries are ſometimes vain; we ſhall, therefore, in this Lecture give the beſt account we can of the *Mountains*, *Springs*, *Rivers*, and the *Sea*.

The ancients ſuppoſed that Mountains were originally occaſioned by the Deluge, before which time they imagined that the earth was a perfect level; and a certain Abbot was taken into cuſtody and puniſhed, for aſſerting that the earth was round; tho' there is ſo great a neceſſity for its being ſo, that according to the properties

with

with which the Almighty has endowed the ſubſtances that compoſe the world, it could not conveniently ſubſiſt in any other form; for, not to mention the formation of rivers, which are generally occaſioned by the miſts that fall on the mountains, if the earth was not round it would be for ever covered with water; for it is, I think, ſuppoſed, that there is full as much water as earth, and as the water is ſpecifically lighter than earth, that would be always uppermoſt, and we ſhould have no dry land.

I proteſt, ſays Lady *Caroline*, I think you carry this argument too far, and ſeem to queſtion the power of the Creator. How can you tell that the earth and water thus diſpoſed would have that effect? From daily experience, Madam, ſays the Philoſopher. Throw this ſtone into the moat and you will ſee it ſink, or this clot of dirt, and it will fall to the bottom. But, ſays ſhe, this is not always the caſe, for when I water my flowers the water ſinks into the ground and diſappears. That is becauſe there is abundantly more earth than water, Madam, ſays he; and the earth being porous, or hollow, the water runs into the cavities and fills them;

but was you to keep on pouring out of the water-pot till all theſe crevices were full, you would find the water flow at top, and the garden-mould, or earth, would remain at the bottom; for if you take a pint pot of earth, and another of water, and mix them ever ſo well together, the earth will in a little time ſubſide or fall to the bottom, and the water will be ſeen at the top. This is to me a demonſtration, Madam; and it is ſo far from calling in queſtion the wiſdom of God, that it is vindicating his wiſdom in the works of Creation. So that you may perceive from hence, as well as from the motion of the heavenly bodies, that the earth is round, and that the ancients were in an error.

And with regard to Mountains, tho' the Deluge might throw up many, and much alter the face of the earth, yet from the great uſe mountains are of in collecting the waters of the atmoſphere into ſprings and rivers, it is reaſonable to ſuppoſe there were mountains even in the firſt age of the world.

If I am not miſtaken, ſays Lady *Twylight*, it has been ſuppoſed, even by men of learning, that this irregularity of the earth's ſurface was occaſioned by ſome

Comets ſtriking againſt it; and this opinion, I know, put Lady *Lucy* and many others in great pain when the late Comet was expected. What ſay you to this, young Gentleman?

I am unable to anſwer for all the extravagant conceits and ridiculous follies of the human race, Madam, ſays he, and your Ladyſhip might as well expect me to give a reaſon for the poor Soldier's propheſying an earthquake ſome time ago, and of the terrors of the people on that occaſion, as to account for this. That the Earth has undergone amazing changes ſince its firſt formation, is, I think, evident from the contents of ſome mountains even in our own country, in which we find not only petrefactions in abundance, but the ſhells of ſea fiſh, and even the bones of animals that were never inhabitants of this climate. At *Reading* in *Berkſhire*, which is above forty miles from the ſea, there is a ſtratum of oyſter-ſhells which appear like real oyſters, and are ſpread through a hill of conſiderable extent; they lie upon a chalky rock in a bed of ſand, much reſembling that of the ſea, and the upper part of the hill, which is a loamy ſoil, is thirty or forty feet perpendicular above them; and at

Burton, near *Petworth* in *Suſſex*, was dug out of a pit, the bones or ſkeleton of an elephant. Numberleſs curioſities of this kind have been diſcovered here, (ſome of which I ſhall take particular notice of in my next courſe of Lectures) but I think there are few but what may be accounted for from the effects of the deluge, earthquakes, and ſubterraneous fires. Earthquakes at the bottom of the ſea, for inſtance, have ſometimes thrown up mountains or little iſlands, with the fiſh upon them, which have been covered by the ſandy or looſe earth giving way and falling over them. It is not long ſince an iſland was raiſed in this manner, in the *Archipelago*, of ten miles circumference, the hills of which abound with oyſters not yet petrified, and which are much larger than thoſe taken on the the coaſt, whence we may conclude, that they were thrown up from the deepeſt part of the ſea. Sea-fiſh have been alſo found in other mountains, ſome of which have been petrified, while others have been found with the fleſh only browned or mummied.

And from the amazing quantity of fire contained in the earth, and of the ſubterranean air rarified thereby, great alterations muſt have been made in its ſurface, in the courſe of ſo many years.

Very well, ſays Lady *Caroline*, and ſo you are going to turn the earth into a hot-bed, and I ſuppoſe we, who are its inhabitants, are by and by to be complimented with the title of muſhrooms and cucumbers, or perhaps pumpkins. This is fine philoſophy, indeed. Have patience, my dear, ſays the Marchioneſs. Patience, Ma'am, returned Lady *Caroline*, why I hope your Ladyſhip would not have me believe, that we have a furnace of fire under us? I don't know, Madam, whether it be immediately under us or not, replied the little Philoſopher; but that there are a number of thoſe furnaces in the earth is beyond diſpute, and is evidently proved by the great number of burning mountains, which are continually ſending up flames, attended with large ſtones and metallic ſubſtances. I am ſorry his Grace of *Galaxy* is gone, Madam, for he would have ſet you right in this particular, which, pardon me, I ſhall not attempt, ſince I find my veracity is ſo much queſtioned. The company all laughed at the Philoſopher in a *pet*; but the Marchioneſs took up the matter, and ſoon put an end to the diſpute.

pute. She blamed Lady *Caroline* for offering to decide upon a point which ſhe did not underſtand; and then turning to the young Gentleman, told him, that patience ought to be a principal ingredient in the character of a Philoſopher: upon which Lady *Caroline* and he compoſed their difference with a mutual ſmile, and after aſking the Marchioneſs pardon for betraying too much warmth, even in the cauſe of truth, he told Lady *Caroline*, ſhe ſhould have ſome account of theſe mountains from the beſt authority, when taking a book out of his pocket, he read as follows:

“ The moſt famous of theſe mountains is *Ætna* in *Sicily*, whoſe eruptions of flame and ſmoke are diſcovered at a great diſtance, by thoſe that ſail on the *Mediterranean*, even as far as the harbour of *Malta*, which is forty *German* miles from the ſhore of *Sicily*. Tho' fire and ſmoke are continually vomiting up by it, yet at ſome particular times it rages with greater violence. In the year 1536 it ſhook all *Sicily*, from the firſt to the twelfth of *May*; after that, there was heard a moſt horrible bellowing and cracking, as if great guns had been fired: there were a great many houſes overthrown throughout the whole iſland. When this ſtorm had continued about eleven days, the ground opened in ſeveral places, and dreadful gapings appeared here and there, from which iſſued forth fire and flame with great violence, which in four days conſumed and burnt up all that were within five leagues of *Ætna*. A little after the funnel, which is on the top of the mountain, diſgorged a great quantity of hot embers and aſhes, for three whole days together, which were not only diſperſed throughout the whole iſland, but alſo carried beyond ſea to *Italy*; and ſeveral ſhips that were ſailing to *Venice*, at two hundred leagues diſtance, ſuffered damage. *Facellus* hath given us an hiſtorical account of the eruptions of this mountain, and ſays, that the bottom of it is one hundred leagues in circuit.

HECLA, a mountain in *Iceland*, rages ſometimes with as great violence as *Ætna*, and caſts out great ſtones. The impriſoned fire often, by want of vent, cauſes horrible ſounds, like lamentations and howlings, which make ſome credulous people think it the place of Hell, where the ſouls of the wicked are tormented.

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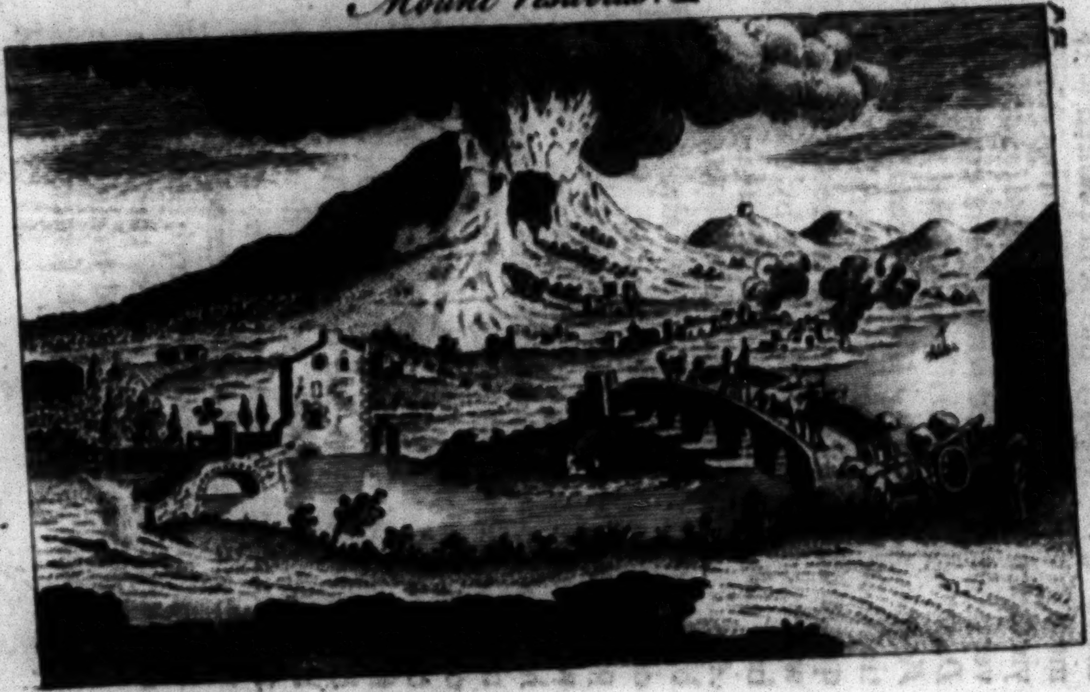
Mount Vesuvius.



VESUVIUS in *Campania*, not far from the town of *Naples*, tho' it be planted with moſt fruitful vines, and at other times yieldeth the beſt *Muſcadel* wine; yet it is very often annoyed with violent eruptions. *Dion Caſſius* relates, that in the reign of *Veſpaſian*, there was ſuch a dreadful eruption of impetuous flames, that great quantities of aſhes and ſulphureous ſmoke were not only carried to *Rome* by the wind, but alſo beyond the *Mediterranean*, into *Africa*, and even into *Egypt*. Moreover, birds were ſuffocated in the air, and fell down dead upon the ground, and fiſhes periſhed in the neighbouring waters, which were made hot and infected by it. There happened another eruption in *Martial's* time, which he elegantly deſcribes in one of his *Epigrams*, and laments the ſad change of the mountain, which he ſaw firſt in its verdure, and immediately after black with aſhes and embers. When the burning ceaſed, the rain and dew watered the ſurface of the mountain, and made theſe ſulphureous aſhes and embers fruitful, ſo that they produced a large increaſe of excellent wine; but when the mountain began to burn again, and to diſgorge fire and ſmoke afreſh, (which ſometimes happened within a few years) then were the neighbouring fields burnt up, and the highways made dangerous to travellers.

A mountain in *Java*, not far from the town of *Panacura*, in the year 1586, was ſhattered to pieces by a violent eruption of glowing ſulphur (tho' it had never burnt before) whereby (as it was reported) 10,000 people periſhed in the under-land fields: It threw up large ſtones and caſt them as far as *Pancras*, and continued for three days to throw out ſo much black ſmoke, mixed with flame and hot embers, that it darkened the face of the Sun, and made the day appear as dark as the night."

There are a great number of other mountains, or (as your Ladyſhip is pleaſed to call them) furnaces in the known world, which I ſhall take ſome notice of in my next courſe of Lectures.

We come now to the conſideration of Springs, which are occaſioned principally, we may ſuppoſe, by the water exhaled from the ſea, rivers, lakes, and marſhy places, and, forming clouds, are diſperſed by the winds. Theſe clouds, when they are ſo collected together as to become too heavy to be ſupported by the air, fall down in rain to water the herbs and plants, but thoſe that are lighter, being driven aloft in the air, daſh againſt the mountains, and to them give up their contents in ſmall particles; whence entering the crevices, they deſcend till they meet together, and form Springs; and this is the reaſon why we have ſuch plenty of Springs in mountainous countries, and few or none in thoſe that are flat. And you may obſerve, that it frequently rains in hilly countries, when it is clear and fine in the valleys beneath; for the air in the valleys is denſe enough to ſupport the clouds and keep them ſuſpended; but being driven up among the mountains, where, in conſequence of their height, the air is ſo much lighter, they deſcend in miſts or ſuch ſmall drops of rain that will not run off, as is the caſe in a heavy rain, but ſink into the crevices of the earth in the manner already mentioned. Now that a great part of this water is exhaled from the ſea, may be known by the extraordinary rains and great dews which fall upon iſlands that are ſurrounded by the ſea: But ſome Springs, it is reaſonable to ſuppoſe, have their ſource from the ocean, ſince thoſe which we meet with near the ſea, are generally ſomewhat ſalt or brackiſh.

Theſe ſprings thus formed by the miſts

on mountains, and the rain meeting together, form little rivulets or brooks, and thoſe again uniting, compoſe large rivers, which empty themſelves into the ſea, and in this manner the water, exhaled from the ſea by the ſun, is returned to it again; for Providence has eſtabliſhed ſuch wiſe laws or regulations for the world, that no part of the elements can be annihilated. But the very large rivers muſt have ſome other ſource beſides the ſprings formed by the miſts, dews, and rains, ſince theſe ſeem inſufficient to ſupport their prodigious diſcharge; it is therefore no improbable conjecture to ſuppoſe that they have ſome communication with the ſea, and that the ſalt water is purified and rendered ſweet by paſſing through the ſand, gravel, and crevices of the earth. And this I ſhall endeavour to prove in my next Courſe of Lectures.

Lakes are collections of water contained in the cavities of the ſurface of the earth, ſome of which are ſaid to be ſtagnant, and made up of the waſte water that flows, after rain or ſnow, from the adjacent countries, and theſe muſt be unwholſome. Other Lakes are ſupplied by rivers, the contents of which they receive and convey under ground, to form other ſprings and rivers; others, again, are fed by ſprings which ariſe in the Lake itſelf, and ſome (as that of *Haerlem*, and other ſalt Lakes) have a communication, it is ſuppoſed, with the ſea, whence they receive their waters, and afterwards diſcharge them by ſubterranean ſtreams.

The Sea is a great collection of waters in the deep valleys of the earth; I ſay, in the deep valleys; for if there were not prodigious cavities in the earth to contain this amazing quantity of water, thus collected together, the whole ſurface of the globe would be overflowed; for the water being lighter than the earth, would be above the earth, as the air is above the water.

Now you ſpeak of the Sea, ſays the Marchioneſs, I wiſh you would tell me, why the Sea water is always ſalt. Madam, replied he, I wiſh I could, but it is beyond the reach of my Philoſophy; and, indeed, I believe, of any Philoſophy whatever. You might as well aſk me, why there is water, as why there is ſalt in the water, which indeed ſeems almoſt as much an element as that: And I have often thought, from the prodigious quantity of ſalt diſtributed in the earth and water, that it muſt have qualities that we know not of, and anſwer purpoſes in the ſcale of Being with which we are unacquainted.

The moſt remarkable quality in the Sea, next to its ſaltneſs, is that motion or riſing and falling of the water, which we call *tides*, and which is occaſioned by the attraction of the Moon; for that part of the water in the great ocean, which is neareſt the Moon, being ſtrongly attracted, is raiſed higher than the reſt; and the part oppoſite to it, on the contrary ſide, being leaſt attracted, is alſo higher than the reſt: and theſe two oppoſite ſides of the ſurface of the water, in the great ocean, following the motion of the Moon from Eaſt to Weſt, and ſtriking againſt the large coaſts of the Continent, from thence rebound back again, and ſo make *floods* and *ebbs*, in narrow ſeas and rivers, at a diſtance from the great ocean. This alſo accounts for the periodical times of the *tides*, and for their conſtantly following the courſe of the Moon.

LECTURE V.

Of MINERALS, VEGETABLES, *and* ANIMALS.

COULD a Philoſopher condeſcend to envy the Great, it would not be for their ſumptuous palaces and numerous attendants, but for the means and opportunities they have of enquiring into the ſecrets of Nature, and contemplating the wonderful works of God. There is no ſubject ſo worthy of a rational creature, except that of promoting the happineſs of Mankind; and none, except that, can give a man of refined taſte, and good underſtanding, ſo much real ſatisfaction. But 'tis our misfortune, that few engage in thoſe enquiries, but men of ſmall eſtate, whoſe circumſtances will not permit them to ſpare the time, nor ſupport the expence of travelling, which is often neceſſary to obtain the knowledge they ſeek after, and for the want of which they are obliged to depend on the relations of thoſe, who have not, perhaps, been ſo accurate or ſo faithful as they ought. Conſidering the quantity of foreign drugs that are uſed in *Britain*, it is amazing how little even thoſe who deal in them know of the matter; ſo little, indeed, that they cannot tell where they grow, or how they are found or manufactured; are unable to diſtinguiſh the genuine from the factitious, and may therefore, through miſtake, often ſubſtitute the one for the other. Health and Life are of too much conſequence to be trifled with; yet theſe are neglected, while Faſhion, Dreſs, and Diverſions, are ſought after throughout the world. This is a melancholy conſideration; but this, you'll ſay, is no part of our Lecture, therefore we ſhall drop a ſubject which has thruſt itſelf, as it were, into our way, and ſpeak of the contents of the earth and its products, and inhabitants: for this globe, beſides the earth and water which are neceſſary for the production and ſupport of Plants and Animals, contains other materials which have been found uſeful to Man. That Reflecting Teleſcope, this Gold Watch, and Lady *Caroline*'s Diamond Ear-rings, were all dug out of the Earth; at leaſt, the materials were there found of which theſe things are compoſed.

Thoſe ſorts of earth which, with the aſſiſtance of rain, produce Vegetables or

Plants in ſuch abundance, are *common mould, loam*, *clay*, and *ſandy ſoils*. There are earths, alſo, that are different from theſe, and which are uſed in medicine, as the *Japan Earth*, *Armenian Bole*, &c.

The barren parts of the earth are, for the moſt part, *ſand*, *gravel*, *chalk*, and *rocks*; for theſe produce nothing, unleſs they have earth mixed with them.—Of barren ſands there are various kinds, though their chief difference is in their colour; for the ſand which we throw on paper, to prevent blotting, and that the maid throws on the floor, are both compoſed of little irregular ſtones, without any earth, and of ſuch there are large deſerts in ſome parts of the world, and one in particular, where *Cambyſes*, an Eaſtern Monarch, loſt an army of 50,000 men. Sure, ſays Lady *Caroline*, you muſt miſtake, Sir. How was it poſſible for a whole army to be loſt in that manner? Why, Madam, returned the Philoſopher, the wind, as it frequently does in thoſe parts, raiſed the ſands in clouds for many days together, and the whole army was ſmothered. And if you read the Life of *Alexander the Great*, you'll find, Madam, that his army was in great danger, when he croſſed the ſame deſert, in his frantick expedition to viſit the temple of his pretended Father *Jupiter Ammon*—But we return to our ſubject.

Beſides theſe materials which compoſe the ſurface of the earth, if we dig deeper, we frequently find bodies very different from thoſe we diſcover near the ſurface; and theſe, becauſe they are diſcovered by digging into the bowels of the earth, are called by the common name of *Foſſils*; though under this head are included all *metals*, and *metallic ores*, *minerals*, or half *metals*, ſtones of various ſorts, *petrifactions*, or *animal* ſubſtances turned into ſtone; and many other bodies which have a texture between ſtone and earth, as, *oker* of ſeveral ſorts, with one of which the Farmers colour their ſheep; *black lead*, with which are made thoſe pencils that we uſe for drawing; and ſome kinds of *chalk*, *ſea coal*, and other bodies that are harder than earth, and yet not of the conſiſtency of perfect ſtone.

Of *ſtones*, there are an amazing variety. They are claſſed by Naturaliſts under two heads, that is to ſay, *ſpars* and *cryſtals*; and by others into *vulgar* and *precious ſtones*. Some of the moſt conſiderable, both for beauty and uſe, are *marble*, *alabaſter*, *porphyry*. *granite*, *free-ſtone*, &c. *Flints*, *agats*, *cornelians*, and *pebbles*, under which kind are placed the *precious ſtones*, otherwiſe called *gems* or *jewels*; which are only *ſtones* of an exceſſive hardneſs, and which, when cut and poliſhed, have an extraordinary luſtre. The moſt valuable of theſe are *diamonds*, *rubies*, *ſaphires*, *amethyſts*, *emeralds*, *topazes*, and *opals*.

But there are other ſtones, which, tho' void of beauty, may, perhaps, have more virtue than many of thoſe already mentioned; ſuch as the *loadſtone*, which has the property of directing the needle in the mariners compaſs always to or near the North Pole; by which means we are enabled to ſail even in the darkeſt night Such alſo are *whetſtones*, with which we ſharpen our knives and other edge tools; *limeſtones*, *talc*, *calamine*, or *lapis calaminaris*, and many others.

Beſide the bodies already mentioned, there are alſo found in the earth a variety of ſalts, ſuch as *rock ſalt*, or *ſal gem*, *vitriol*, *nitre*, and many others.

The *minerals*, *marcaſites*, or *ſemi-metals*, as they are called by the Chemiſts, are *antimony*, *zink*, *biſmuth*, &c. Theſe are not inflammable, ductile, or malleable, but are hard and brittle, and may be reduced to powder, and the firſt after melting, may be calcined by fire.

Mercury or *quickſilver*, has generally been claſſed with *ſemi-metals*, and, indeed, ſometimes among the metals; but I think it ought not to be claſſed under either of theſe heads, but conſidered ſeparately; as alſo ſhould *brimſtone*, though it be a part of the compoſition of *crude antimony*.

Ores are thoſe kinds of earth which are dug out of mines, and that contain in them metallic particles from whence metals are extracted.

Metals are diſtinguiſhed from other bodies by their weight, fuſibility or melting in the fire, and their malleability, or giving way, and extending under the ſtroke of the hammer without breaking in pieces. Theſe are ſix, viz. *gold*, *ſilver*, *copper*, *tin*, *lead*, and *iron*, which laſt is the moſt valuable of them all. They are ſeldom or never found in any part of the earth but what is mountainous, which, by the way, in ſome meaſure proves what we ventured to aſſert in a former Lecture, *viz.* that there were mountains before the Deluge; for that there were metals before the Deluge appears by what is ſaid in Holy Writ concerning *Tubal Cain*, who wrought in braſs, *&c.* and was the inventor of organs.

All *ſtones*, *minerals*, and *metals*, are ſuppoſed to grow organically in the earth from their proper ſeeds, as vegetables do on the earth's ſurface. And what ſort of bodies are to be found deeper in the earth, I mean towards its centre, is unknown to us; for we can only make ourſelves acquainted with the foſſils contained in its ſhell, and the vegetables and animals on its ſurface, whoſe nature and properties alone are, indeed, too many to be diſcovered by human ſagacity.

Of VEGETABLES *or* PLANTS.

The Vegetables or Plants growing on the earth may be divided into three claſſes, I mean thoſe of *herbs*, *ſhrubs*, and *trees*.

Herbs are thoſe ſort of vegetables whoſe ſtalks are ſoft, and have no wood in them, as *parſley*, *lettuce*, *violets*, *pinks*, *graſs nettles*, *thiſtles*, and an infinite number of others.

Shrubs are thoſe plants which, tho' woody, never grow into trees, but bow down their branches near the earth's ſurface; ſuch are thoſe plants that produce *roſes*, *honeyſuckles*, *gooſeberries*, *currants*, and the like.

But trees ſhoot up in one great ſtem or body, and riſe to a conſiderable diſtance from the ground before they ſpread their branches, as may be ſeen by the *oak*, the *beech*, the *elm*, the *aſh*, the *fir*, the *walnut-tree*, *cherry-*

ry-tree, and others. From the bodies of trees we have our timber for building, and of the oak-tree in particular for ſhip-building, no timber being ſo tough, ſtrong, and durable, as old *Engliſh* oak; nor does any tree, perhaps, yield more timber; for there was one lately ſold for forty pounds, from *Langley* woods, belonging to the Biſhop of *Salisbury*, which meaſured ſix feet two inches in diameter, contained ten tons of timber, and was ſuppoſed to be a thouſand years old.

From a ſmall acorn ſee the oak ariſe
Supremely tall, and tow'ring in the ſkies!
Queen of the groves, her ſtately head ſhe rears,
Her bulk increaſing with the length of years;
Now ploughs the ſea, a warlike gallant ſhip!
Whilſt in her womb deſtructive thunders ſleep!
Hence *Britain* boaſts her wide extenſive reign,
And by th' expanded acorn rules the Main.

The moſt conſiderable parts of plants are the *root*, the *ſtalk*, the *leaves*, the *flowers*, and the *ſeed*; moſt of them have theſe ſeveral parts, tho' there are ſome, indeed, that have no ſtalk, as the *aloe*; others that have no leaves, as *ſavine*; and others that have no flowers, as *fern*. But I think there are none without *root* or *ſeed*, though ſome ſay that *fern* is an exception as to the laſt.

What moſt excites our wonder with reſpect to plants (and what, indeed, has been the ſubject of much diſpute among the learned) is their *nouriſhment* and *propagation.*—This, ſays Maſter *Bloſſom*, I have often heard my father diſcourſe upon when I have been in the garden with him; but as what he ſaid has eſcaped my memory, I ſhould be glad, Sir, if you would tell me how they receive their nouriſhment, and how their ſpecies are propagated. A diſquiſition of this nature, ſays the little Philoſopher, would take up too much of your time, and could not be underſtood without reciting many experiments and obſervations that have been made by the learned; I ſhall, therefore, defer the conſideration of theſe till my next courſe of Lectures. I ſee no reaſon for that, ſays Maſter *Wilſon*, nor to me does there appear any difficulty in the affair. Why, they receive their nouriſhment from the earth, don't they? And you ſow the ſeeds of the old plants and they produce new ones.

You are too apt, Maſter *Wilſon*, ſays the Philoſopher, to talk about things you don't underſtand. The earth has not, perhaps, ſo much to do with the nouriſhment of plants as is generally imagined; for, without water, and particularly rain water and dew, there would be but little increaſe in vegetables of any kind; and this you may know

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by the languid ſtate of plants in a dry ſeaſon, tho' watered ever ſo often from the river or well. This is known alſo by the ſmall quantity of earth which is taken up in the growth of plants; for both Mr. *Boyle* and Dr. *Woodward* raiſed ſeveral plants in earth watered with rain or ſpring-water, and even diſtilled water, and upon weighing the dry earth, both before and after the production of the plants, they have found that very little of it was diminiſhed or taken up by the plant. Taken up by the plant, ſays Lady *Caroline*, in ſome ſurprize, why you don't imagine there is earth in herbs and trees? Indeed I do, Madam, replied the little Philoſopher, and have already hinted as much in what was ſaid on the four elements, and at the ſame time told your Ladyſhip, if I miſtake not, how it might be extracted from the plant; which was, by burning the plant to aſhes, and waſhing off the ſalts, as your laundry maid does when ſhe makes lye; for when theſe ſalts are waſhed away the remainder will be earth.

If the earth contributes ſo little towards the production of plants, ſays Maſter *Blyth*, the water, I apprehend, muſt be a good deal concerned, and that is evident from the quantity of water which moſt plants require to keep them in a ſtate of health and vigour. Your obſervation, ſays the Philoſopher, deſerves ſome notice; but how will you account for the growth of plants in ſandy deſerts where it ſeldom rains, and of plants, too, that contain juices in great abundance; for God Almighty, for the preſervation of his creatures, has cauſed thoſe wonderful plants to grow in ſuch barren deſerts to ſupply, in ſome meaſure, the want of water; and ſome are ſo conſtructed as to hold great quantities of water for the uſe of animals. This is the caſe of the ground Pine *, which, tho' it ſeems to grow like a fungus or excreſcence on the branch of a tree, often contains a pint or quart of ſweet water for the birds, beaſts, and even men, to refreſh themſelves with in the ſultry climates where they abound. But a plant may hold much water for the ſubſiſtance of animals, and yet not ſubſiſt on water itſelf; and that this is the caſe experience teſtifies. Dr. *Woodward* put a plant of *ſpearmint*, which weighed 27 grains, into a phial of water, where it ſtood 77 days, and in that time drank up 2558 grains of ſpring water; and then being taken out weighed 42 grains, ſo that the increaſe was only 15 grains, which is not a hundredth part of the water expended.—We are therefore to look for other principles of vegetation than what are generally known; but this I ſhall conſider in my next courſe of Lectures.

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* For a more particular account of this plant, we muſt refer our readers to the *Chriſtian's Magazine*, Numb. II. where it is introduced with ſuitable reflections to demonſtrate the wonders of God in the works of creation.

What the plant can obtain by the earth, water, and otherwiſe for its nouriſhment, is generally ſuppoſed to be received by the fibres of the roots, and conveyed by the ſtalk or body of the plant up into the branches and leaves thro' ſmall tubes, and then returned by the bark to the root again; ſo that there is a conſtant circulation of vital fluids in plants as well as in animals. But I am inclined to think, that a great part of the nouriſhment of plants is received by the pores of the leaves and ſkin or bark, as well as from the root, elſe how happens it that plants are ſo much refreſhed by the dew?

Plants alſo require air for their nouriſhment, as well as a circulation of theſe alimentary juices; for they reſpire as well as animals, and for that reſpiration require freſh air, and even exerciſe; ſince we know that plants, that are always confined in a cloſe room, will never riſe to perfection. And that they perſpire as well as animals is evident from the inſtance of the *mint* growing in ſpring water above-mentioned; for if not a hundredth part of the water taken up by that plant became a part of the plant itſelf, all the reſt muſt be perſpired thro' the pores, or little imperceptible holes in the ſkin and leaves. This calls to my mind, ſays Lady *Caroline*, a charge my Lord Marquis gave me, which was, never to ſit in the *yew arbor*; for the matter perſpired by the yew-tree, ſays he, is noxious, and will make you ill; and I believe that was the reaſon of his Lordſhip's ordering that old arbor to be demoliſhed.

But pray, Sir, why and in what manner can plants perſpire? For the ſame reaſon, Madam, and in the ſame manner, perhaps, that animals do, returned the Philoſopher. It is occaſioned, probably, by heat; for we know that they perſpire abundantly more in ſummer than in winter; nay, when this vegetative principle has been long checked by cold, it breaks out with ſuch force, when warm weather comes on, that it is no uncommon thing, in the cold northern countries, to ſee the trees covered with ſnow one week, and with bloſſoms the next.

Plants are propagated different ways, but the moſt general method is by ſeed. Some plants, however, are raiſed by a part of the root of the old plant ſet in the ground, as potatoes; others, by new roots propagated from the old ones, as *hyacinths* and *tulips*; others, by cutting off branches and putting them into the ground, which will there take root and grow, as *vines*; and others are propagated by grafting and budding, or inoculation. But what I repreſented as moſt myſterious, and intend for the ſubject of a Lecture in my next Courſe, is the Sexes of Plants; for many ſorts have both male and female organs, and the one will not flouriſh and increaſe without the aid of the other.

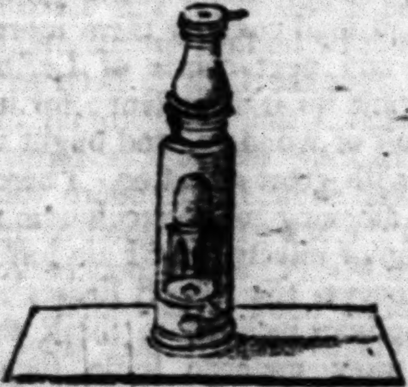
Of ANIMALS.

We are now to ſpeak of the Animals that inhabit the earth, which are naturally divided into *Men* and *Brutes*.

Of Men, there ſeem to be four different ſorts—Nay, don't be frightned, Lady *Caroline!*—Sir, ſays ſhe, I ſhould have made no objection, had you ſaid four hundred, provided you had diſtinguiſhed them according to their different diſpoſitions.—True, Madam, ſays the Philoſopher, or according to their different features, and then you might have ſaid four hundred thouſand; for it is very true, Madam, tho' very wonderful, that out of four hundred thouſand faces you will not find two exactly alike; and but for this miraculous and gracious providence in God, the world would have been all in confuſion. But the diviſion I would willingly make of men, Lady *Caroline*, is that of *white*, *tawney*, *black*, and *red*; and theſe you will allow are, with reſpect to colour, eſſentially different. Moſt of the *Europeans*, and ſome of the *Aſiatics*, are *white*; the *Africans* on the coaſt of the *Mediterranean* ſea are *tawney*; thoſe on the coaſt of *Guinea black*; and the original *Americans*, *red*, or of a red copper colour: How they came ſo is only known to their Maker; and therefore I beg you would ſpare yourſelves the trouble of aſking me any queſtions on that head.

Brutes may be divided into four claſſes; that is to ſay, 1. *Aerial*, or ſuch as have wings and fly in the air, as *birds*, *waſps*, *flies*, &c. 2. *Terreſtrial*, or thoſe who are confined to the earth, as *quadrupeds*, or four-footed beaſts; *reptiles*, which have many feet; and *ſerpents*, which have no feet at all. 3. *Aquatick*, or thoſe who live in the water, as *fiſh* of all kinds, whether they are covered with ſcales or ſhells, or are like the *eel*, without either. 4. *Amphibious*, or thoſe that can live for a long time either upon the earth, or in the water; as *otters*, *alligators*, *turtles*, &c. I ſay for a long time, becauſe I apprehend that the uſe of both theſe elements are neceſſary for the ſubſiſtance of thoſe animals; and that tho' they can live for a conſiderable time upon land in the open air, or as long in the water, excluded in a manner from air, yet they would languiſh and die, if confined entirely either to the one or the other of theſe elements.

In this diviſion of animals we are to obſerve, however, that there are ſome which cannot be conſidered under either claſs, as being, as it were, of a middle nature and partaking of two kinds; thus *bats* ſeem to be part beaſts and part birds. Some *reptiles*, likewiſe, and ſome of the water animals, want one or more of the five ſenſes with which other animals are endowed, as *worms*, *cockles*, *oyſters*, &c. If I miſtake not, ſays Lady *Caroline*, I have ſeen the animals divided into different claſſes in books of Natural Hiſtory, and deſcribed under the heads of *beaſts*, *birds*, *fiſhes*, and *inſects*. Very true, Madam, ſays the Philoſopher; but the preſent method ſuits my preſent purpoſe the beſt, and can make no alteration in the nature of things; however, as I have not yet mentioned the word *inſects*, tho' they are included in my diviſion of animals, it may be neceſſary for me to obſerve, that they are ſo called from a ſeparation in their bodies, by which they are ſeemingly divided into two parts, thoſe parts being only joined together by a ſmall ligament, as in *flies*, *waſps*, &c. And as ſome of theſe *inſects* undergo different changes, and in time become quite different animals, I ſhall conſider them more particularly in my next courſe of Lectures, not having time for it at preſent; for it is a field that is full of wonders, and ought to be examined with great attention. There is ſomething ſo amazing and miraculous in the tranſformation of inſects, that I am loſt in reflection whenever the ſubject ſtrikes my mind, and ſometimes inclined to think that other animals may undergo ſome ſuch change. Who, that had not made the obſervation, would think, Madam, that this *grub* crawling, or rather ſleeping here, would by and by become a fine *butterfly*, decked out in all the gaudy colours of the rainbow; or that this *ſilk-worm* ſhould be capable of aſſuming ſo many different forms. And is it not altogether as miraculous, that if ſome animals are cut in pieces, every ſeparate piece or part of the original animal will become one entire animal of itſelf? Yet that the *polype* or *polypus* is endowed with this property has been demonſtrated; and I have here one that was divided into ſeveral parts ſome time ago, which parts are now become diſtinct and perfect polypes and alive, as you may ſee by viewing them thro' this microſcope.



But the ſagacity and acute ſenſes of ſome of the animals (in which they ſeem to exceed man) are altogether as ſurprizing, as I ſhall demonſtrate in my next courſe. In your next courſe, ſays Maſter *Wilſon*, why don't you do it now? Peace, prythee, *Tom*, ſays the Philoſopher, learn this firſt, and then I'll talk to you about *beavers* building of houſes; *bees* forming themſelves into a ſociety and chooſing a Queen to govern them; *birds* knowing the latitude and longitude, and ſailing over ſea thro' vaſt tracks of air, from one country to another, without the uſe of any compaſs; and of other things, which are ſufficient, I think, to lower the pride of man, and make even Philoſophers bluſh at their own ignorance.—And now, Lady *Caroline*, prepare to hear a few hard words and I will finiſh this Lecture. But why muſt it be finiſhed in an unintelligible manner? ſays the Lady. Becauſe I cannot deliver what I am going to ſay, Madam, without making uſe of the terms of art, ſays he, and thoſe I muſt deſire your Ladyſhip, and the reſt of the good company, to learn from Mr. *Newbery's* pocket dictionary, or ſome other book of that kind.

All animals receive their food at the mouth, and moſt animals, but eſpecially thoſe of the human kind, chew it there till it is intimately mixed with the ſaliva or ſpittle, and thereby prepared for the eaſier and better digeſtion in the ſtomach. When the ſtomach has digeſted the food it is thence conveyed into the *guts* (pardon the expreſſion, Ladies, for I cannot avoid it) through which it is moved gently, by what is called the *periſtaltick motion*; as it paſſes there, the *chyle*, which is the nutritive part, is ſeparated by the *lacteal veins*, from the excrementitious part, and by them conveyed into the blood, with which it circulates, and is concocted into blood alſo; and this circulation is thus performed: The blood being, by the *vena cava*, brought into the right ventricle of the heart, by the contraction of that muſcle, is forced into the *pulmonary artery* of the lungs; where the air, which is continually inſpired or drawn in by the lungs, mixes with and enlivens it; and from thence the blood, being conveyed by the *pulmonary vein* into the left ventricle of the heart, the contraction of the heart forces it out, and by the arteries diſtributes it into all parts of the body, from whence it returns by the veins to the right ventricle of the heart, to purſue the ſame courſe again, in order to communicate life and heat to every part of this wonderful machine, the body. But this is not all; for, according to Anatomiſts, ſome part of the blood, in the courſe of its circulation, goes to the head; where a portion of it is ſeparated by the brain, and concocted into *animal ſpirits*, which are diſtributed by the nerves, and impart ſenſe and motion throughout the body. The inſtruments of motion, however, are the muſcles; the fibres, or ſmall threads, whereof contracting themſelves, move the different parts of the body; which in ſome of them is done by the direction of the mind, and called *voluntary motion*; but, in others, the mind ſeems not to be concerned, and therefore theſe motions are called *involuntary*.

This is the progreſs of animal life; by which you will perceive, that a man may, even at home, and within himſelf, ſee the Wonders of God in the Works of Creation.

We have now finiſhed our ſurvey of the Univerſe, and conſidered theſe great maſſes of matter, the Stars and Planets; but particularly our earth and its inhabitants; all which large bodies are made up of inconceivably ſmall *bodies*, or *atoms*: And by the figure, texture, bulk, and motion of theſe inſenſible *corpuſcles*, or infinitely ſmall bodies, all the phænomena of larger bodies may be explained.

LECTURE VI.

Of the FIVE SENSES *of* MAN, *and of his* UNDERSTANDING.

AT our next meeting there was a great deal of good company, who came to hear the *Boys Philoſophy*, as they called it; on which account I could obſerve that Maſter *Teleſcope* took leſs pains to be underſtood by the young Gentlemen and Ladies, and addreſſed himſelf more particularly to thoſe of greater abilities.

As the company came in laughing, and affected to talk, and behaved in a ſupercilious manner, which even ſome great perſonages do in theſe our days of refinement, he ſtood ſilent, till my Lord Marquis deſired him to open the Lecture; upon which he bowed, to his Lordſhip and the reſt of the company and began; but had ſcarcely ſpoke three words before he was interrupted by Sir *Harry*; he therefore ſtopt for ſome time, and then began again; but the tongue of the young Baronet ſoon ſilenced him, and he ſtood, without ſpeaking, a conſiderable time. On this, the company looked at each other, and the Marquis bad him go on. My Dear, ſays the Marchioneſs, how can you expect this young Gentleman to read a long Lecture, when you know that Sir *Harry*, who loves to hear himſelf talk of all things, has not patience to ſupport ſo much taciturnity! Why, Madam, ſays the Ambaſſador of *Bantam* (who came in with the Marquis) I thought we had all been aſſembled to hear this Lecture. That was indeed the intention of our meeting, ſays the Marchioneſs; but I hope your Excellency knows the polite world better, than to expect people ſhould be ſo old faſhioned as to behave, on theſe occaſions, with any ſort of good-manners or decorum. In my country, ſays the Ambaſſador, all the company keep a profound ſilence at theſe meetings. It may be ſo, replied the Marchioneſs; but, I aſſure your Excellency, it is not the cuſtom here. Why, Sir, I have been often interrupted in the middle of a fine air, at an Oratorio, by a Gentleman's whiſt ing an Hornpipe; and at the Rehearſal at St. *Paul*'s, it is no uncommon thing to hear both Gentlemen and Ladies laugh louder than the organ. Huſh, Madam, ſays the Marquis, if your friends and neighbours are fools, you ought not to expoſe them, and eſpecially to foreigners.

Take care, while you condemn this unpolite behaviour in others, that you don't run into it yourſelf. *Politeneſs* is the art of being always agreeable in company; it can therefore ſeldom deal in *ſarcaſm* or *irony*; because it ſhould never do any thing to abridge the happineſs of others; and you ſee, my Dear, you have made Sir *Harry* uneaſy, for he bluſhes. The company laughed at Sir *Harry*, who joined them, and being determined to hold his tongue, our Philoſopher thus proceeded.

After the curſory view of Nature, which was concluded in my laſt Lecture, it may not be amiſs to examine our own faculties, and ſee by what means we acquire and treaſure up a knowledge of theſe things; and this is done, I apprehend, by means of the *ſenſes*, the operations of the *mind*, and the *memory*, which laſt may be called the Storehouſe of the *underſtanding*. The firſt time little Maſter is brought to a looking-glaſs, he thinks he has found a new play-mate, and calls out *Little boy! little boy!* for having never ſeen his own face before, it is no wonder that he ſhould not know it. Here is the idea, therefore, of ſomething new acquired by *ſight*.—Preſently the father, and mother, and nurſe come forward to partake of the p.100

A Boy finds himself in the Glaſs.

child's diverſion. Upon ſeeing theſe figures in the glaſs with whom he is ſo well acquainted, he immediately calls out, *There, Papa! there, Mamma! there, Nurſe!* And now the *mind* begins to operate; for feeling his father's hand on his own head, and ſeeing it on the little boy's head in the glaſs, he cries, *There me!*—Now this tranſaction is lodged in the *memory*, which, whenever a looking-glaſs is mentioned, will give back to the mind this idea of its reflecting objects.

The whole company were pleaſed with this familiar demonſtration; but Sir *Harry* aſked how he came, of all things, to make uſe of a looking-glaſs? Becauſe, Sir, ſays he, it is an object with which ſome people are the moſt intimately acquainted.—As Sir *Harry* is an egregious fop, this reply produced a loud laugh, and Maſter *Teleſcope* was looked upon to be a *Wit* as well as a *Philoſopher*; however, I am inclined to think the expreſſion was accidental, and not intended to hit Sir *Harry*, becauſe I know his good ſenſe would not permit him to treat an elder and ſuperior in that manner —The laugh being a little ſubſided, our Philoſopher thus proceeded on his Lecture.

All our ideas, therefore, are obtained either by *ſenſation* or *reflection*, that is to ſay, by means of our five ſenſes, as *ſeeing*, *hearing*, *ſmelling*, *taſting*, and *touching*, or by the *operations of the mind*.

Before you proceed further, ſays the Counteſs of *Twylight*, you ſhould, I think, explain to the company what is meant by the term *idea*. That, I apprehend, is ſufficiently explained by what was ſaid about the looking glaſs, ſays the Philoſopher; but if your Ladyſhip requires another definition you ſhall have it. By an *idea*, then, I mean that *image* or *picture*, Madam, which is formed in the *mind*, of any thing which we have *ſeen*, or even *heard talk of*; for the mind is ſo adroit and ready at this kind of *painting*. that a town, for inſtance, is no ſooner mentioned, but the *imagination* ſhapes it into form and preſents it to the *memory*. None of this company, I preſume, have ever ſeen *Dreſden*, yet there is not one, perhaps, but has formed, or conceived in his mind, ſome *idea* or *picture* of that unhappy place. Not one of us ever ſaw the *Nabob*'s prodigious army and elephants, yet we have all formed to ourſelves a *picture* of their running away from a ſmall party of our brave countrymen, led againſt them by the gallant and courageous Colonel *Clive*. When we read in the news-papers a deſcription of a *ſea-engage-*

ment, or of the taking of *Louiſbourg*, *Quebec*, or any other important fortreſs, the mind immediately gives us a *picture* of the *tranſaction*, and we ſee our valiant officers iſſuing their orders, and their intrepid men furling their ſails, firing their guns, ſcaling the walls, and driving their foes before them. To purſue this ſubject a little farther—No man has ever ſeen a *dragon*, a *griffin*, or a *fairy*; yet every one has formed in his mind a *picture*, *image*, or, in other words, an *idea*, of theſe imaginary beings—Now when this *idea* or *image* is formed in the mind from a view of the object itſelf, it may be called an *adequate* or *real idea*; but when it is conceived in the mind without ſeeing the object, it is an *inadequate* or *imaginary idea*.

I ſhall begin my diſcourſe of the Senſes with that of the SIGHT, ſays he, becauſe, as Mr. *Addiſon* obſerves, the *ſight* is the moſt perfect and pleaſing of them all. The organ of *ſeeing* is the *eye*, which is made up of a number of parts, and ſo wonderfully contrived for admitting and refracting the rays of light, that thoſe which come from the ſame point of the object, and fall upon different parts of the pupil, are again brought together at the bottom of the eye, and by that means the whole object is painted on a membrane called the *retina*, which is ſpread there.

But how is it poſſible, ſays Sir *Harry*, for you to know that the object is thus painted on the *retina?* In ſome meaſure from the ſtructure of the eye, replied the Philoſopher; but, I think, it is manifeſt from that diſorder of the eye which Surgeons call the *gutta ſerena*, the very complaint which my Lord's Butler has in one of his eyes. If you examine it you will find that he has no ſight with that eye, tho' it looks as perfect as the other with which he ſees well; this is, therefore, occaſioned by ſome paralytic, or other diſorder in that membrane, or expanſion of the optic nerve, which we call the *retina*, and proves that all viſion ariſes from thence.

That which produces in us the ſenſation which we call Seeing, is *light*, for without *light* nothing is viſible. Now light may be conſidered either as it radiates from luminous bodies directly to our eyes, and thus we ſee thoſe luminous bodies themſelves; as the *Sun*, a lighted *torch*, &c. or as it is reflected from other bodies, and thus we ſee a *flower*, a *man*, *&c.* or a picture reflected from them to our eyes by the rays of light.

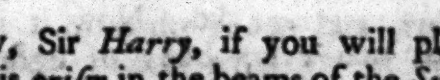
It is to be obſerved that the bodies which reſpect the light are of three ſorts, 1. Thoſe that emit the rays of light, as the ſun and fix'd ſtars. 2. Thoſe that tranſmit the rays of light, as the air; and, 3. Thoſe that reflect them, as the Moon, the Earth, Iron, &c. The firſt we call *luminous*, the ſecond, *pellucid*, and the third, *opaque* bodies. It is alſo to be obſerved, that the rays of light themſelves are never ſeen; but by their means we ſee the luminous bodies from which they originally came, and the opaque bodies from which they are reflected; thus, for inſtance, when the Moon ſhines, we cannot ſee the rays which paſs from the Sun to the Moon; but, by their means, we ſee the Moon from whence they are reflected.

If the eye be placed directly in the Medium through which the rays paſs to it, the Medium is not ſeen; for we never ſee the air through which the rays come to our eyes. But if a *pellucid* body, thro' which the rays are to paſs, be placed at a diſtance from our eye, that body will be ſeen, as well as thoſe bodies from whence the rays came that paſs through it to our eyes; for inſtance, he who looks through a pair of ſpectacles, not only ſees bodies through them, but alſo ſees the glaſs itſelf; becauſe the glaſs, being a ſolid body, reflects ſome rays of light from its ſurface; and being placed at a convenient diſtance from the eye, may be ſeen by thoſe reflected rays, at the ſame time that bodies, at a greater diſtance, are ſeen by the tranſmitted rays; and this is the reaſon, perhaps, why objects are ſeen more diſtinctly through a reflecting, than through a refracting teleſcope.

There are two kinds of opaque bodies, namely, thoſe that are not *ſpecular*, as the *moon*, the *earth*, a *horſe*, a *man*, &c. and others that are *ſpecular* or *mirrors*, like thoſe in reflecting teleſcopes, whoſe ſurfaces being poliſhed, reflect the rays in the ſame order as they came from other bodies, and ſhew us their images. And rays that are thus reflected from opaque bodies, always bring with them to the eye the idea of colour, tho' this colour in bodies is nothing more than a diſpoſition to reflect to the eye one ſort of rays more copiouſly or in greater plenty than another; for particular rays impreſs upon the eye particular colours; ſome are *red*, others *blue*, *yellow*, *green*, &c. Now it is to be obſerved, that every body of light which comes from the *Sun* ſeems to be compounded of theſe various ſorts of rays; and as ſome of them are more *refrangible* than others, that is to ſay, are more turned out of their courſe in paſſing from one medium to another, it ne-

neceſſarily follows that they will be ſeparated after ſuch refraction, and their colours appear diſtinct. The moſt *refrangible* of theſe are the *violet*, and the leaſt the *red*; the intermediate ones, in order, are *indigo*, *blue*, *green*, *yellow*, and *orange*.

How do you know, Mr. Philoſopher, that colours are ſeparated in this manner? ſays Sir *Harry*. I have no notion of theſe doctrines without demonſtration. That you may have, if you pleaſe, replied the Philoſopher. Pray, Maſter *Lovelace*, hand me that *priſm*.



Now, Sir *Harry*, if you will pleaſe to hold this *priſm* in the beams of the *Sun*, you will ſee the colours ſeparated in the manner I have mentioned. Pleaſe to look, Lady *Caroline*, the ſeparation is very pleaſing, and you will find what I ſaid of the *rainbow* in my third Lecture confirmed by this experiment.

All theſe rays differ not only in *refrangibility* but in *reflexibility*; I mean in the property of being reflected ſome more eaſily than others. And hence ariſe all the various colours of bodies.

The *whiteneſs* of the Sun's light is owing, it is ſuppoſed, to a mixture of all the original colours in a due proportion; and *whiteneſs* in other bodies, is a diſpoſition to reflect all the colours of light, nearly in the ſame proportion as they are mixed in the original rays of the Sun; as *blackneſs*, on the contrary, is only a diſpoſition to abſorb or ſtifle, without reflection, moſt of the rays of every ſort that fall on thoſe bodies; and it is for that reaſon, we may ſuppoſe, that *black* cloaths are warmer than thoſe of any other colour; and are therefore rejected by the inhabitants of hot countries, who chooſe ſuch colours for their raiment as will reflect the *Sun's* rays, and not abſorb them.

Light, as we have already obſerved, is ſucceſſively propagated with moſt amazing ſwiftneſs; for it comes from the Sun to the Earth in about ſeven or eight minutes, tho' at the diſtance of ſeventy millions of miles.

HEARING is the next moſt extenſive of our ſenſes, the organ of which is the *Ear*, whoſe ſtructure is extremely curious, as may be ſeen in the books of Anatomy.

That which the ear conveys to the brain is called ſound, tho' till it reaches and affects the perceptive part, it is in reality nothing but motion; and this motion, which produces in us the perception of ſound, is a vibration of the air, occaſioned by a very ſhort and quick tremulous motion of the body from whence it is propagated. That ſound is conveyed in this manner, may be known by what is obſerved and felt in the ſtrings of muſical inſtruments, and of bells, which tremble or vibrate as long as we perceive any ſound come from them; and from this effect which they produce in us they are called Sounding Bodies.

Sound is propagated at a great rate, but not near ſo faſt as light. I don't know that, ſays Lady *Caroline*. Then your Ladyſhip has forgot what paſſed in our Lecture upon *Air*, replied the Philoſopher; and to confirm by experiment what I advanced, I muſt beg his Lordſhip to order one of the ſervants to go a diſtance into the park, and diſcharge a *gun*. The Gentlemen were averſe to this, it being an obſervation they had made an hundred times; but to gratify the young people, my Lord ordered his Game-keeper out, and when the piece was diſcharged, they had the ſatisfaction of ſeeing the fire long before they heard the report.

SMELLING is another ſenſe which ſeems to be excited in us by external bodies, and ſometimes by bodies at a great diſtance; but that which immediately affects the noſe, the organ of ſmelling, and produces in us the ſenſation of any ſmell, are effluvia or inviſible particles that fly from thoſe bodies to our *olfactory* nerves. How do you prove this, young Gentleman? ſays Sir *Harry*. Sir, replied the Philoſopher, had you been here yeſterday, you would not have aſked this queſtion, for, as the wind was North-Eaſt, the *effluvia* from my Lord's brick-kilns were ready to ſuffocate us; but now the wind is turned to the South-Weſt you obſerve no ſuch thing, becauſe thoſe *effluvia* are driven a contrary way.

The power which ſome bodies have of emitting theſe *effluvia* or ſteams without being viſibly diminiſhed, is to me moſt amazing; yet that it is true we know by abundant experience. A ſingle grain of *muſk* will ſcent a thouſand rooms, and ſend forth theſe odoriferous particles for a great number of years without being ſpent. Surely theſe particles muſt be extremely ſmall; yet their minuteneſs is nothing when compared with the particles of light, which pervade and find their way thro' glaſs, or to the magnetic *effluvia* which paſs freely through metallic bodies; whereas thoſe effluvia that produce the ſenſation of ſmelling, notwithſtanding their wonderful property of ſcenting all places into which they are brought, and without any ſenſible diminution, are yet too groſs to paſs the membranes of a bladder, and many of them will ſcarce find their way through a common white paper.

There are but few names to expreſs the infinite number of ſcents that we meet with. I know of none but thoſe of *ſweet*, *ſtinking*, *rank*, *muſty*, and *ſour*; for ſo barren is our language in this reſpect, that the reſt are expreſſed either by degrees of compariſon, or by epithets borrowed from bodies that produce ſcent, which muſt, in many caſes, be very inexpreſſive; for the ſmell of a *roſe*, of a *violet*, and of *muſk*, tho' all ſweet, are as diſtinct as any ſcents whatever.

The next ſenſe under our conſideration is TASTE, the organ of which is the *tongue* and the *palate*, but principally the tongue; ay, and a pretty organ it is, says Lady Caſ *voliue.* When uſed with your Ladyſhip's diſcretion, Madam, replied the Philoſopher. But I muſt obſerve to your Ladyſhip, and the reſt of the good company, that though bodies which emit *light*, *ſounds*, and *ſcents*, are ſeen, heard, and ſmelt at a diſtance; yet no bodies can produce taſte, without being immediately applied to the organ; for tho' the meat be placed at your mouth, you know not what taſte it will produce till you have touched it with your tongue or palate.

Though there are an amazing variety of taſtes, yet here, as in ſcents, we have but a few general names to expreſs the whole; *ſweet*, *ſour*, *bitter*, *harſh*, *ſmooth*, and *rank*, are all that I can recollect; and our other ideas of taſte are generally conveyed by borrowed ſimilitudes and expreſſions like thoſe of *ſcents.* It is ſurprizing, ſays the Ambaſſador, that in this age of gluttony, your language ſhould be ſo barren as not to afford you words to expreſs thoſe ideas which are excited by exquiſite flavours. Sir, ſays the Marquis, this may be eaſily accounted for. I muſt inform your Excellency, that we are indebted for our moſt expreſſive terms to the Poets, who were never much acquainted with good eating, and are leſs ſo ſince literature has loſt its zeſt. Very true, my Lord, ſays Sir *Harry*, their diſhes, poor creatures, have lately been of the mental kind; but had you a few rich Poets that could afford to live like people of taſte, inſtead of your ſweets and your ſours, and ſuch old faſhion terms, you would have the *calapaſh* and *calape* flavour, the *live-lobſter* flavour, the *whipt-pig* flavour, and a liſt of others, as long——as my arm. Fye, Sir *Harry*, ſays the Marchioneſs, no more of that, I beg; you know Lady *Caroline* can't bear the name of Barbarity. Nor I neither, ſays the Ambaſſador, but pray what barbarity is there in this, Madam? Oh! none at all, replied Sir *Harry*, I only meant to inſinuate that ſome of our great people are not content with having food brought from the *Eaſt* and *Weſt Indies*, and every other part of the world, to gratify their palates, but they muſt roaſt lobſters alive, and whip young pigs to death to make them tender. Good God! ſays the Ambaſſador, are there people in *England* capable of ſuch acts of inhumanity? A man that will do that would murder me, if the law did not ſtand between us; and the law is but a poor ſcreen where humanity is loſt and conſcience is lulled aſleep. I'll apply to the King my maſter for my diſmiſſion, and no longer live with a people who have adopted ſuch diabolical cuſtoms. The Ambaſſador was ſo much in a paſſion, that it was with difficulty my Lord Marquis pacified him; and poor Lady *Caroline*, whoſe kind ſoul ſympathizes with every creature in diſtreſs, was in tears at the bare rehearſal of theſe acts of cruelty. Upon which the Baronet was blamed by all the company, except myſelf, and, I think, he never ſhewed ſo much good ſenſe in his life; for there was one in the room who deſerved the reproof.

When the Ambaſſador had ſat down with a ſigh, and Lady *Caroline* had wiped the precious pearly drops from her cheeks, our Philoſopher aroſe and thus purſued his Lecture.

I have already taken notice of four of our ſenſes, and am now come to the fifth and laſt, I mean that of the TOUCH, which is a ſenſe ſpread over the whole body, tho' it is more particularly the buſineſs of the hands and fingers; for by them the tangible qualities of bodies are known, ſince we diſcover by the *touch* of the fingers, and ſometimes, indeed, by the *touch* of other parts of the body, whether things are *hard*, *ſoft*, *rough*, *ſmooth*, *wet*, *dry*, &c. But the qualities which moſt affect this ſenſe are *heat* and *cold*, and which, indeed, are the great engines of Nature;

ſuch diabolical cuſtoms. The Ambaſſador was ſo much in a paſſion, that it was with difficulty my Lord Marquis pacified him; and poor Lady Caroline, whoſe kind ſoul ſympathiſes with every creature in diſtreſs, was in tears at the mere relation of theſe acts of cruelty. Upon which the [illegible] was blamed by all the company, except myſelf; and, I think, he never [illegible] ſo much good ſenſe in his life; for there was not one in the room who deſerved the reproof.

When the Ambaſſador had finiſhed with a ſigh, and Lady Caroline had wiped the precious pearly drops from her cheeks, our Philoſopher roſe and thus finiſhed his lecture.

I have already taken notice of the [illegible] ſenſes, and [illegible] to the fifth and laſt. I mean [illegible] a ſenſe lodged [illegible] but it is more particularly the [illegible] hands and fingers; for by them the tangible qualities of bodies are known; theſe we diſcover by the touch of the fingers, and ſometimes, indeed, by the touch of other parts of the body, whether things are hard, ſoft, ſmooth, rough, wet, dry, &c. But the qualities which [illegible] this way, are diſcovered [illegible] which, indeed, are [illegible]

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Chariot fired by Motion

ture; for by a due temperament of thoſe two oppoſite qualities moſt of her productions are formed.

What we call *heat* is occaſioned by the agitation of the inſenſible parts of the body that produces in us that ſenſation; and when the parts of a body are violently agitated, we ſay, and indeed we feel, that body is *hot*; ſo that that which to our ſenſation is *heat*, in the object is nothing but *motion*. Hey-day, ſays Lady *Caroline*, what ſort of Philoſophy is this? Why, Madam, ſays Sir *Harry*, this is a poſition which has been laid down by theſe airy Gentlemen for a long time, but which never has been proved by experiment. Take care, Baronet, ſays the Marquis, or you'll forfeit all pretenſions to Philoſophy. The forfeiture, my Lord, is made already, ſays the Philoſopher; Sir *Harry* has been bold enough to deny that which experience every day confirms for truth. If what we call Heat is not motion, or occaſioned by the motion of bodies, how came my Lord's mill to take fire the other day, when it was running round without a proper ſupply of corn? And how came your poſt-chariot to fire while running down *Breakneck hill*, Sir *Harry*? Conſider, there was nobody with a torch under the axletree; but this is a part of Philoſophy known even to the poor ignorant *Indians*, who, when hunting at a great diſtance from home, and wanting fire to dreſs their meat, take a bow and a ſtring and rub two pieces of wood together till they produce flame. But you may ſee, Sir *Harry*, that heat is occaſioned by the motion of bodies, by only rubbing this piece of ſmooth *braſs* on the table —ſtay, I'll rub it.—It muſt be done briſkly. There, now you'll feel it hot; but ceaſe this motion for a time, and the braſs will become cold again; whence we may infer, that as heat is nothing but the inſenſible particles of bodies put into motion, ſo cold, on the contrary, is occaſioned by the ceſſation of the motion of thoſe particles, or their being placed in a ſtate of reſt.

But bodies appear *hot* or *cold* in proportion to the temperament of that part of the human body to which they are applied; ſo that what ſeems hot to one, may not ſeem ſo to another: This is ſo true, that the ſame body felt by the two hands of the ſame man, may at the ſame inſtant of time appear warm to the one hand, and cold to the other, if with the one hand he has been rubbing any thing, while the other was kept in a ſtate of reſt; and for no other reaſon but becauſe the motion of the inſenſible particles of that hand with which he has been rubbing, will be more briſk than the particles of the other which was at reſt.

I have mentioned thoſe objects which are peculiar to each of our ſenſes, as *light* and *colour* to the *ſight*; *ſound* to the *hearing*; *odors* to the *ſmell*, &c. but there are two others common to all the ſenſes, which deſerve our notice, and theſe are *pleaſure* and *pain*, which the ſenſes may receive by their own peculiar objects; for we know that a proper portion of light is pleaſing, but that too much offends the eye; ſome ſounds delight, while others are diſagreeable, and grate the ear; ſo heat, in a moderate degree, is very pleaſant; yet that heat may be ſo increaſed as to give the moſt intolerable pain. But theſe things are too well known to be longer inſiſted on.

Now from the *ideas* or *conceptions* formed in the mind, by means of our ſenſes, and the operations of the mind itſelf, are laid the foundation of the human underſtanding, the loweſt degree of which is *perception*; and to conceive a right notion of this, we muſt diſtinguiſh the firſt objects of it, which are *ſimple ideas*, ſuch as are repreſented by the words, *red*, *blue*, *bitter*, *ſweet*, &c. from the other objects of our ſenſes; to which we may add the internal operations of our own minds, or the objects of reflection, ſuch as are *thinking*, *willing*, &c. for all our ideas are firſt obtained by *ſenſation* and *reflection*. The mind having gained variety of *ſimple ideas*, by putting them together, forms what are called *compounded* or *complex ideas*, as thoſe ſignified by the words, *man*, *horſe*, *marygold*, *windmill*, &c.

The next operation of the mind (or of the underſtanding) in its progreſs to knowledge, is that of abſtracting its ideas; for by abſtraction they are made general; and a *general idea* is to be conſidered as ſeparated from time and place, and lodged in the mind to repreſent any particular thing that is conformable to it.

Knowledge, which is the higheſt degree of the ſpeculative faculties, conſiſts in the perception of the truth of affirmative or negative propoſitions; and this perception is either immediate or mediate. When, by comparing two ideas together in the mind, we perceive their agreement or diſagreement, as that black is not white; that the whole is bigger than a part; that two and two are equal to four, &c. it is called immediate perception, or *intuitive* knowledge; and as the truth of theſe and the like propoſitions is ſo evident as to be known by a ſimple intuition of the ideas themſelves, they are alſo called *ſelf-evident propoſitions*.

Mediate perception, is when the agreement or diſagreement of two ideas is made known by the intervention of ſome other ideas: Thus if it be affirmed that my Lord's bay horſe is as high as my father's, the agreement or diſagreement may be ſeen by applying the ſame meaſure to both; and this is called *demonſtration*, or *rational knowledge*. The dimenſions of any two bodies which cannot be brought together, may be thus known, by the ſame meaſure being applied to them both.

But the underſtanding is not confined to certain truth; it alſo judges of *probability*, which conſiſts in the *likely* agreement or diſagreement of ideas; and the aſſenting to any propoſition as probable, is called *opinion*, or *belief*.—We have now finiſhed this Courſe of Lectures. I hope not, ſays Lady *Caroline*, with ſome emotion!—Why, Madam, returned the Philoſopher, we have taken a curſory view of natural bodies, and their cauſes and effects; which I have endeavoured to explain in ſuch a manner as to be intelligible, at leaſt, if not entertaining; and pray what more did your Ladyſhip expect? Sir, replied the Lady, I am greatly pleaſed with the account you have given us, and I thank you, Sir, for the pains you have taken to anſwer the many queſtions I have troubled you with. What I had farther to hope, was, that you would have given us, when you was on the ſubject of Animals, ſome ſtrictures on the cruelty with which they are too often treated; and have thrown in reflections and obſervations tending to inforce in mankind a different conduct. This I wiſhed for, and ſhould have been glad to have had Sir *Thomas* and his Lady here at the ſame time; who are both extremely fond of their little domeſtic creatures, and I admire them for their tenderneſs and compaſſion. Theſe feelings and ſentiments of the human heart, Madam, ſays the Philoſopher, add much to the dignity of our nature, and I am greatly delighted with ſuch behaviour; but I am afraid, Lady *Caroline*, that we often miſtake characters of this kind, and take that for humanity and tenderneſs, which is only the effect of fancy or ſelf love. That Sir *Thomas* has compaſſion, I grant you; but I am afraid it is only for himſelf. He loves his dogs and horſes, becauſe his dogs and horſes give him pleaſure; but to other creatures that afford him none, he is abſolutely inſenſible. I have ſeen him, even at *Chriſtmas*, feed his pretty *pupps*, as he calls them, with delicacies; but rave, at the ſame time, in a merciless manner, at poor children who were ſhivering at his gate, and ſend them away empty handed. Our neighbour Sir *William* is alſo of the ſame diſpoſition; he will not ſell a horſe, that is declining, for fear he ſhould fall into the hands of a maſter who might treat him with cruelty; but he is largely concerned in the ſlave trade (which, I think, is carried on by none but *we good Chriſtians*, to the diſhonour of our *cæleſtial Maſter)* and makes no difficulty of ſeparating the huſband from the wife, the parents from the children, and all of them (as well as our own people, who are procured by his *crimps*,) from their native country, to be ſold in a foreign market, like ſo many horſes, and often to the moſt mercileſs of the human race. I remember him in great diſtreſs for his pointer *Phillis*, who had loſt her *puppies*; but the ſame afternoon I ſaw him, without the leaſt compunction of mind, preſs a poor man into the ſea ſervice, and tear him from his wiſe and children; for no other *crime*, but becauſe he had fought bravely for his King and country in the laſt war, and being now ſettled in buſineſs, and having a family, did not chuſe to enter the ſervice again. Is this humanity, Madam? Is this morality? But above all, is this Chriſtianity? And are theſe the bleſſed effects of the liberty we boaſt of?—I don't expect a reply, Lady *Caroline*, for I ſhall have occaſion to ſay much more on theſe ſubjects in my next courſe of Lectures, and then, perhaps, you will honour me with your obſervations. But in the mean time don't let us be miſled by ſpecious pretences. We cannot judge of any man, Madam, by one ſingle action, but by the tenour and reſult of all his actions, and this requires deep penetration and an intimate knowledge of human life.

Benevolence, Lady *Caroline*, ſhould be univerſal, for it is an emanation of the Supreme Being, whoſe mercy and goodneſs are extended to all his creatures; as ours alſo ſhould be, for they are fellow tenants with us of the globe we inhabit.

I have often thought, Madam, that moſt of the miſchiefs which embarraſs ſociety, and render one man contemptible to another, are owing to inordinate *ambition* or extreme love of *power*, and of *wealth*, the means by which it is procured; for all the gold a man poſſeſſes beyond that portion which is requiſite for himſelf and family, only ſerves to inflame his ambition; as all the wine we drink more than is neceſſary to recruit the drooping ſpirits, anſwers no other purpoſe but to intoxicate the mind.

I have ſeen a book, Lady *Caroline*, in my Pappa's library, which gives ſome account of one *Lycurgus*, an old *Grecian* Lawgiver, with whoſe character you ought to be acquainted.—This man, Madam, was of opinion, that religion, virtue, and good manners, were the only natural cements and preſervatives of liberty, peace, and friendſhip; which he found had been deſtroyed and extirpated by means of wealth and ſelf-intereſt; he therefore prohibited the uſe of gold and ſilver, and of all kinds of luxury in the ſtate, and eſtabliſhed ſuch a plan for the education of youth of every denomination, as was moſt likely to confirm and habituate them in the practice of religion and virtue, and ſecure to the *Spartans* and their poſterity the bleſſings of liberty and peace.

The event proved that his inſtitutions were founded on ſound policy, and a perfect knowledge of human nature; for in the ſpace of five hundred years, that is to ſay, from the time of *Lycurgus* to the introduction of wealth in the ſtate by *Lyſander*, in the reign of the firſt *Agis*, there was no mutiny among the people; every man ſubmitted chearfully to the laws of *Lycurgus*, and all were ſo united and powerful in conſequence of their virtue, ſobriety, and the martial diſcipline he had eſtabliſhed (which was that of a national militia) that *Sparta*, a very ſmall inconſiderable State, not only gave laws to the reſt of *Greece*, but made even the *Perſian* Monarchs tremble, though maſters of the richeſt and moſt extenſive empire in the world. But when theſe great and virtuous people of *Sparta* had conquered *Athens*, and from thence introduced wealth and luxury into their own country, they loſt their virtue, dwindled to nothing, and were themſelves enſlaved. Nor is this a matter of wonder; for where Religion and Virtue are ſet at a diſtance, and Wealth leads the way to poſts of honour and truſt, ſome people will ſtick at nothing to obtain gold; but were dignities of this kind conferred on the moſt deſerving, and none but men of virtue and ſuperior abilities promoted to places of truſt and power, there would be no frauds in the State, or violence among the People, and we might then hope to enjoy the felicities of the *Golden Age*.

Man in that Age no rule but Reaſon knew,
And with a native bent did good purſue;
Unaw'd by puniſhment, and void of fear,
His words were ſimple and his ſoul ſincere.
By no *forc'd laws* his paſſions were confin'd,
For *conſcience* kept his heart, and calm'd his mind;
Peace o'er the world, her bleſſed ſway maintain'd,
And e'en in Deſarts ſmiling *Plenty* reign'd.

FINIS.

ADVERTISEMENT.

⁂ The Author of the preceding Sheets has in moſt Places explained the technical Terms, but in all he could not, without encreaſing the Volume beyond the Size intended, or deſtroying the Thread of the Narration; he would, therefore, recommend the occaſional Uſe of ſome good Dictionary, by turning to which the Terms will be ſo fixed in the young Student's Mind, that he will ſeldom be at a Loſs in reading any other Treatiſe on philoſophical Subjects. —Mention is made of the *Pocket Dictionary* (Page 95.) not becauſe the Terms are better defined in that Book than in any other, but becauſe it is ſold only for *three Shillings* bound, and by being contracted into leſs Compaſs than other Dictionaries, is rendered more portable and convenient for the Pocket.

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It has been ſaid, and ſaid wiſely, that the only way to remedy theſe Evils, is to begin with the riſing Generation, and to take the Mind in its infant State, when it is uncorrupted and ſuſceptible of any Impreſſion; To repreſent their Duties and future Intereſt in a Manner that ſhall ſeem rather intended to amuſe than inſtruct, to excite their Attention with Images and Pictures that are familiar and pleaſing; To warm their Affections with ſuch little Hiſtories as are capable of giving them Delight, and of impreſſing on their tender Minds proper Sentiments of Religion, Juſtice, Honour, and Virtue.

‘ When infant Reaſon grows apace, it calls
‘ For the kind Hand of an aſſiduous Care:
‘ Delightful Task! To rear the tender Thought,

'To teach the young Idea how to ſhoot,
'To pour the freſh Inſtruction o'er the Mind,
'To breathe th' inſpiring Spirit, to implant
'The generous Purpoſe in the glowing Breaſt.'
THOMPSON.

How far Mr. *Newbery*'s little Books may tend to forward this good Work, may be, in ſome meaſure, ſeen by what are already publiſhed, and, it is preſumed, will more evidently appear by others which are now in the Preſs.

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